UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF MISSISSIPPI
NORTHERN DIVISION

LATOYA BROWN; LAWRENCE BLACKMON; HERBERT ANTHONY GREEN; KHADAFY MANNING; QUINNETTA MANNING; MARVIN MCFIELD; NICHOLAS SINGLETON; STEVEN SMITH; BESSIE THOMAS; and BETTY JEAN WILLIAMS TUCKER, individually and on behalf of a class of all others similarly situated,

Plaintiffs,

v.

MADISON COUNTY, MISSISSIPPI; SHERIFF RANDALL S. TUCKER, in his official capacity; and MADISON COUNTY SHERIFF'S DEPUTIES JOHN DOES #1 through #6, in their individual capacities,

Defendants.

Civil Action No.
3:17-cv-00347-WHB-LRA

ORAL ARGUMENT REQUESTED

PLAINTIFFS' MOTION TO EXCLUDE THE REPORT AND TESTIMONY OF WILLIAM R. FUNDERBURK

Plaintiffs Latoya Brown, Lawrence Blackmon, Khadafy Manning, Quinnetta Manning, Nicholas Singleton, Steven Smith, Bessie Thomas, and Betty Jean Williams Tucker ("Plaintiffs") respectfully request that the Court exclude the Report and Testimony of William R. Funderburk (ECF No. 267-21, "Mr. Funderburk's Report" or "Funderburk Rep.") submitted by Defendants Madison County, Mississippi ("Madison County") and Sheriff Randall Tucker ("Sheriff Tucker," and with Madison County, "Defendants"), pursuant to Federal Rules of Evidence 104, 401, 402, 403, and 702 ("Motion"). Pursuant to L.U. Civ. R. 7(b)(6)(A), Plaintiffs respectfully request oral

argument on the Motion.[1]

Mr. Funderburk's Report and testimony should be excluded and he should be precluded from testifying as an expert witness in the above-captioned action, as his opinions rely upon unreliable principles and methodologies and reflect a lack of familiarity with the relevant academic literature concerning geocoding best practices. Thus, Mr. Funderburk's Report and testimony do not meet the stringent standards for expert opinions set forth under Federal Rules of Evidence 104, 401, 402, 403, and 702 and *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993) (hereinafter "*Daubert*").

Mr. Funderburk's Report attempts to critique the process by which Dr. Bryan Ricchetti, in his March 13, 2018 expert report (ECF No. 231-1), geocoded the locations of roadblocks implemented by the Madison County Sheriff's Department ("MCSD") to determine the census tract in which each roadblock was located. In response to Mr. Funderburk's Report, Plaintiffs have submitted the Rebuttal Expert Report of Dr. Patricia Frontiera and the Rebuttal Expert Report of Dr. Bryan Ricchetti, dated July 2, 2018 and attached hereto as exhibits to this Motion, which detail how Mr. Funderburk's Report and opinions are conclusory, unsupported, and do not comport with standard geocoding evaluation practices or statistical analysis. One of Mr. Funderburk's primary opinions relates to his review and evaluation of geocoded roadblock locations, leading to his claim that Dr. Ricchetti's analysis purportedly reflects certain geocoding errors. The methodology Mr. Funderburk applies in his review, however, does not reflect "ground truth validation," as he claims, but rather is based upon the unverified, unsworn, and

[1] Because the issues presented by the Motion overlap with the issues presented by Plaintiffs' pending Motion for Class Certification (ECF No. 231), Plaintiffs respectfully request that argument on the instant Motion be held jointly with argument on Plaintiffs' Motion for Class Certification.

inadmissible statements from a single MCSD Deputy. Courts in this Circuit consistently exclude expert opinions where they simply restate the opinions of others and do not reflect any independent expertise. *See Robroy Indus.-Texas, LLC v. Thomas & Betts Corp.*, Nos. 2:15-CV-512-WCB, 2:16-CV-198-WCB, 2017 WL 1319553, at *9 (E.D. Tex. Apr. 10, 2017) (collecting cases).

Mr. Funderburk also provides several other conclusory, speculative, and unsupported opinions regarding, among other issues, that street intersections cannot be accurately geocoded, that census tract boundary issues and coordinate reference system issues purportedly impact Dr. Ricchetti's analyses, and that use of a match-score cutoff as a measure of geocoding quality and accuracy was inappropriate. As further described in the accompanying Memorandum of Law, Mr. Funderburk's Report and opinions are contrary to the relevant academic literature, and Mr. Funderburk does not offer any tests to show that any of these issues actually affected Dr. Ricchetti's conclusions. Mr. Funderburk further attempts to give expert testimony regarding purported errors in Dr. Ricchetti's statistical analyses of the data, but Mr. Funderburk is not an expert on, and Defendants do not appear to be offering him as an expert on, statistical analysis. Mr. Funderburk does not possess the experience or education necessary to qualify as an expert in statistical analysis. In short, Mr. Funderburk's numerous *ipse dixit* assertions are not the product of reliable principles and methodology.

For the foregoing reasons, and as described in greater detail in Plaintiffs' accompanying Memorandum of Law in support of this Motion, Mr. Funderburk's Report and testimony must be excluded in their entirety as methodologically unreliable, irrelevant, and otherwise inadmissible, as they do not meet the requirements for expert opinions set forth under Federal Rules of Evidence 104, 401, 402, 403, and 702 and *Daubert*.

In support of this Motion, Plaintiffs submit an accompanying Memorandum of Law, which is incorporated herein as if set forth in full, and the exhibits listed below:

1. **Exhibit 1**: Report of William R. Funderburk (May 8, 2018)
2. **Exhibit 2**: Rebuttal Expert Report of Patricia Frontiera, Ph.D. (July 2, 2018)
3. **Exhibit 3**: Rebuttal Expert Report of Bryan Ricchetti, Ph.D. (July 2, 2018)
4. **Exhibit 4**: Excerpts from Transcript of Deposition of William Funderburk (June 20, 2018).

WHEREFORE, for the reasons set forth herein and in Plaintiffs' accompanying Memorandum of Law, Plaintiffs' Motion to exclude the Report and Testimony of William R. Funderburk should be granted.

Respectfully submitted this 2nd day of July, 2018.

By: */s/ Joshua Tom*
Joshua Tom

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CERTIFICATE OF SERVICE

I hereby certify that on July 2, 2018, I caused the foregoing **PLAINTIFFS' MOTION TO EXCLUDE THE REPORT AND TESTIMONY OF WILLIAM R. FUNDERBURK** to be electronically filed with the Clerk of the Court using the CM/ECF system, through which copies have been served to:

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EXHIBIT 1

IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF MISSISSIPPI
NORTHERN DIVISION

LATOYA BROWN, et al.,	)	PLAINTIFFS
	)	
vs.	)	Civ. No. 3:17-cv-347 WHB LRA
	)	
MADISON COUNTY, MISSISSIPPI, et al.,	)	DEFENDANTS
	)	
	)	
_____	)	

REPORT OF WILLIAM R. FUNDERBURK

May 8, 2018

EXHIBIT 21

1. QUALIFICATIONS

1. I am a Field Applications Scientist with the University of Southern Mississippi's Gulf Coast Geospatial Center (GCGC) as well as adjunct faculty member for the Division of Marine Science's Department of Hydrography. I have been employed with USM GCGC since 2013. I have a B.S. in Geography (2012) and M.S. in Geography (2014), both from USM's Department of Geography and Geology in 2012 and 2014. I also have a minor in Mathematics.

2. I have been adjunct faculty with the Department of Hydrography since 2016 where I have been responsible for developing and teaching two courses for the Department's undergraduate program: 3D positioning and Remote Sensing. As one of the only undergraduate hydrographic surveying programs in the country, and one of two programs nationally, all graduate and undergraduate courses in this renowned program are taught to International Hydrography Organizations (IHO) category A or B, surveying standards.

3. Designated by NOAA in 2007 as the Mississippi Spatial Reference Center (MSRC), GCGC is partly responsible for ensuring that accurate geopositional information is collected, distributed, maintained and included in the National Spatial Reference System (NSRS). We are also tasked with creating useful and comprehensive geographic information systems (GIS) datasets using new and existing geodetic, remote sensing, terrestrial gravity and other physical geographic information and research.

4. The GCGC established, maintains and operates a statewide network of 52 continuously operating reference stations (CORS) in Mississippi. The network is real – time capable providing the most accurate and precise Global Positioning Systems (GPS) solutions and serves approximately 1,000 institutional users throughout the state as well as provides direct support for Mississippi's Department of Transportation (MDOT).

5. In 2013 the GCGC became the lead institution for NOAA's gulf-wide Regional Geospatial Modeling Program, which is a five-year five-state comprehensive program to combine and expand on the National Spatial Reference System assets in the Gulf of Mexico Region. GCGC serves as lead to several subsidiary entities: Texas A&M University Corpus Christi's Texas Spatial Reference Center (TSRC), Louisiana State University's (Louisiana Spatial Reference Center), The State of Alabama's Department of Transportation and the University of Florida.

6. The position of field applications scientist serves as a research and applications geoscientist for the GCGC. The purpose of this position is to research, develop, and implement innovative field and mathematical/computer-based capabilities for environmental modeling. This position am also responsible for cultivating external relationships and engaging in both internally and externally led collaborative scientific research efforts as a role of lead or participant.

7. In my work with USM's GCGC as a field applications scientist I have developed an expertise in high-accuracy, high precision Geospatial and Geographic analyses. Specifically, my

expertise is in the development and of high accuracy, high precision GPS experiments, and novel applications of GPS in augmented environmental biophysical modeling.

8. I have been employed through competitive regional geospatial modeling research grants since I began my career at the University of Southern Mississippi in 2013. A list of other significant research projects as well as respective grant numbers, conference presentations, and publications can be found in my CV, which is attached to this report as **APPENDIX A**.

9. I have not testified as an expert at trial or by depositions in the last four years. I have co-authored 3 peer-reviewed scientific publications in the last four years with another currently in revision. I am being compensated at a rate of $150/hour for my services.

2. ASSIGNMENT AND SUMMARY OF FINDINGS

2.1 Assignment

10. I have been asked by Wise Carter Child & Caraway, P.A., to serve as a subject matter expert in, geography and geographic analysis using the geographic information systems (GIS) software, ArcGIS.

11. My specific objectives were 1) investigate information about geocoded roadblock locations; 2) evaluate the ability to conduct comprehensive geographic analysis for roadblocks in Madison County; 3) to review and evaluate methodology used by Dr. Ricchetti and the team at Cornerstone in their geographic analysis and geocoding and 4) to provide technical assistance generally on GIS issues.

12. As part of my work, I reviewed all the documents listed in **APPENDIX B**. I reviewed Dr. Ricchetti's report, deposition, and production datasets containing his geographic analysis. Additionally, I interviewed Deputy Rylon Thompson as part of my ground truth validation of roadblock locations.

2.2 Summary of Findings

13. There is very little mention of geographical methods used in Dr. Ricchetti's report. In fact, his explanation is limited to the contents of footnote 14 of his report. This completely glosses over the complex issues related to geocoding MCSD roadblock locations and assigning them to census tracts.

14. Most of the roadblocks addresses only provide intersection information, while a very small number contain street-numbered addresses similar to postal addresses. The intersection-only addresses are inadequate to allow the precise or accurate geocoding for anything beyond the software programs estimated center of the roadways. As a geographer, I would believe this to be the location where the centerlines of the two intersecting streets cross.

15. Based on my experience, you would not be able to accurately geocode roadblocks near an intersection or an approaching street with intersection-only address information. For example, you would to need to know the locations orientation from the center point of the intersection and how many feet out from the intersection the roadblock occurred from the center of the intersection.

16. Dr. Ricchetti's census-tract assignments are completely unreliable and uninsightful regarding the location of roadblocks. There are countless erroneously geocoded locations and/or incorrect assignments to census tracts. Likewise, his assignments fail to account for the fact that more than 662 of the 2,004 roadblocks locations he straddle two more census tracts, which his analysis failed to account for.

17. Dr. Ricchetti's address "cleaning process" and quality assurance technique involving a "match score" of "90 or better" did nothing to improve the reliability of his data or methods. It actually injects more error into the overall analysis.

18. It is my opinion no geographer would be able to reliably, accurately, or precisely geocode the specific roadblock locations using only the name of nearby intersecting streets. This opinion is based upon my experience and my review of the documentation and data described.

19. Based on the materials I have reviewed, Dr. Ricchetti did not conduct any generally accepted procedures in geocoding roadblock locations. Further, it is obvious that he did not perform any accuracy assessment on their geocoded locations.

3. METHODOLOGY AND DATA

20. In this section, I explain Dr. Ricchetti's methodology and my methodology for conducting a geographic analysis of Dr. Ricchetti's data. I also provide an overview of geocoding.

3.1 Dr. Ricchetti's Geographic Analysis

21. Dr. Ricchetti's report provides very little information on his geographical analysis. In fact, the only explanation is in footnote 14, which provides "I convert the addresses into longitude and latitude coordinates. Only roadblocks for which an accurate set of coordinates can be determined are used in my analysis. This removes 14.9% of the roadblocks listed in the three data sources for my analysis."

22. His report makes no mention of any tool or methodology he used to explain how he converted intersection-only addresses to geographic coordinates. He simply used the term "geocode" to identify he converted addresses. This explanation glosses over the complex processes related to accurately and reliably geocoding roadblock locations. That process was made even more difficult here since a large majority of MCSD roadblock locations are identified only by nearby intersections, not postal addresses.

23. From reviewing Dr. Ricchetti's deposition, I found that he was unable to explain the process that he used to convert intersection names to geographic coordinates of roadblock locations.

24. Despite the very limited information I attempt to explain Dr. Ricchetti's (or whoever did it for him) methodology for geocoding roadblock locations and assigning them to census tracts in Madison County.

25. Dr. Ricchetti identified three sources of roadblock information in footnote 23: data from the CAD file (1,697 roadblocks), data from handwritten notes by MCSD's DUI personnel (161 roadblocks), and data gathered from Plaintiffs' counsels' review of individual incident reports (146 roadblocks). He combined these sources into a single dataset.

26. Using a program called ArcGIS, someone conducted a geographic analysis on his behalf and based on this analysis assigned the geocoded roadblock locations to census tracts. As discussed below, I am very familiar with ArcGIS. [1]

27. It appears that someone took the "original addresses" from this dataset and processed them into "cleaned address." There is no information on how this task was performed or what rules, if any, were used to ensure reliability.

28. Many of these original roadblock addresses did not include street numbers and, thus, were not addresses in the common sense of the term. Many original addresses only provided the names of the nearby intersecting streets. As discussed below, whatever process they used, it did not resolve the ambiguity of geocoding point data from intersection information.

29. Dr. Ricchetti's production file indicates that the "cleaned" address information was entered into ArcGIS. ArcGIS then converted this address information into longitude and latitude coordinates. The process for converting addresses into geographic coordinates is commonly referred to as "geocoding."[2]

30. The precision, accuracy, and reliability of geocoding are determined by the amount of specific geographic or location information available. For example, if the only specific geographic information entered into ArcGIS is "East Capitol Street, Jackson, Mississippi" ArcGIS will locate "East Capitol Street", but will be unable to accurately identify where on East Capitol Street something is located without more specific information. If the location is identified as "East Capitol / Congress Street, Jackson, Mississippi," ArcGIS will estimate that it is in the middle of that intersection.

31. Each geocoded position from Dr. Ricchetti's work represents ArcGIS's interpretation of where a MCSD conducted a roadblock or checkpoint based on the cleaned addresses

32. Dr. Ricchetti said that he reviewed ArcGIS's "match score" to evaluate the newly-geocoded locations. He said he eliminated all locations that did not have a "match score" of 90 or higher. As discussed below in Part 4, this "match score" does not ensure accuracy and reliability, despite its name. Here, I believe his methods might have actually injected more error into the data.

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[1] Dr. Ricchetti admitted during his deposition that he did not do the geocoding. (Tr. 163:6). He also admitted that no one on the team working under him was a geographer. (Tr. 196:13).

[2] ArcGIS defines geocoding as "the process of assigning a location, usually in the form of coordinate values, to an address." *See ArcGIS v10.5 Tool Description*.

33. The "match score" is the only quality control standard referenced by Dr. Ricchetti. However, "match score" does not distill the data down to what Dr. Ricchetti described in his deposition.

34. The Census Bureau divides the country into different-sized subdivisions for its counts and estimates. Census tracts are small, relatively permanent statistical subdivisions of a county or equivalent entity that are updated infrequently, but just prior to each decennial census.[3] Census tracts generally have a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people. Census tract boundaries generally follow visible and identifiable features, typically roads.

35. Dr. Ricchetti "assigned" the remaining geocoded location to one of Madison County's 21 census tracts. There was no explanation as to how this was done by Dr. Ricchetti. When joining datasets together in ArcGIS, there are specific types of joins that can be performed depending upon the type of data and attributes associated with it. This is especially important here where you have different layers of data.

36. Using these "assignments", he then totaled up the all the roadblocks from 2012 – 2017 in each of Madison County's 21 census tracts. Based on the totals from this assignment, he conducted various analyses.

3.2 My Review of Geocoded Roadblock Information

37. I reviewed Dr. Ricchetti's report and deposition to learn more about the process for cleaning addresses and geocoding. I also reviewed data sets provided in Dr. Ricchetti's production file.

38. I also reviewed a composite list of two of Dr. Ricchetti's datasets, which are referred to as "Compiled Unique Roadblocks." This list includes 1,697 CAD roadblocks and 146 Additional Roadblocks, totaling 1,843 roadblocks from 2012 through 2017. Based on Dr. Ricchetti's report, these roadblocks were at 361 unique locations in Madison County. These roadblocks are sorted by frequency and listed in **APPENDIX D** and are referred to as "Compiled Unique Roadblocks." This list does not include the 161 handwritten roadblocks used by Dr. Ricchetti and referenced in footnote 23 of his report.

39. Dr. Ricchetti's production file contained several datasets with pre and post geocoded address information. For example, a folder located in his production file "Expert Report Production File→ Data→ Input→ Roadblock Data" had several datasets contained in subfolders with "raw," "cleaned," "unique_addresses," and "geocoding_output." I reviewed these files in Arc GIS v.10.5 to plot the positions by their longitude and latitude coordinates (i.e., their X and Y coordinate attribute fields).

40. ArcGIS software program is used for surveying, socio-economics, and heavy processing of remotely sensed datasets such as Lidar, Sonar, Radar and multispectral image datasets. Geographers and hydrographers use ArcGIS all the time.

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[3] "Geographic Terms and Concepts," U.S. Census Bureau available at https://goo.gl/k98EMy .

41. While ArcGIS is a very robust software and has lots of capabilities, it is very complicated and requires a technical understanding of what the software will do (or is doing) when performing one of its many functions. Geographers and hydrographers are formally trained on the software throughout their education. We teach classes on it and it is virtually part of every analysis we do.

42. Using ArcGIS, I reviewed Dr. Ricchetti's findings and attempted to verify some of the geocoded locations using ground truth.

4. GEOGRAPHIC ANALYSIS

43. Again, there was very little information regarding Dr. Ricchetti's process, tools, or software used in geocoding as well as his methods for deriving geographic coordinates of roadblock locations. Also, there was no mention of data standards or GIS pre-processing/calibration techniques performed, such as defining datum, coordinate system and projection, performed to ensure quality assurance of resultant output.

4.1 Ability to Geocode Roadblocks Using Only Nearby Intersection Information

44. Most roadblocks addresses maintained by the MCSD only include an intersection address. This is true for address information found the datasets, including the addresses in the Compiled Unique Addresses.

45. As I mentioned above, the Compiled Unique Roadblocks dataset contained 361 locations. Only 24 out of the 361 locations contain a street numbered address. Thus, from this sample, I estimate that 93.4% of the roadblock locations were identified by intersection-only information.

46. I interviewed Deputy Rylon Thompson for my purposes of my review. Based on my discussion with Deputy Thompson, it does not appear that the address information kept by MCSD contains enough information to perform geographic analysis such as geocoding.

47. This led to numerous geocoding errors, in turn, affecting the "assignment" of roadblocks to census tracts. These errors are best illustrated by reviewing the Compiled Unique Roadblocks that was compiled from Dr. Ricchetti's production file, **APPENDIX D**.

48. What follows is an incomplete list of geocoding and census tract assignment errors that I have identified in my review and discussions. The exhibits referenced below are attached to my report:

a. Exhibit 1 shows several roadblock locations near the Reservoir. None of the mapped locations show where MCSD conducts roadblocks. Point No. 18 should be 0.21 miles north on Harbor Drive, while Point No. 159 should be south on Harbor Drive. Both should be in the same location. MCSD does not conduct roadblocks on Breakers Lane, which is, apparently, which is what Point No. 287 depicts. Point No. 287 on Dr. Ricchetti's addresses is identified as "BREAKERS LN, MADISON COUNTY, MS." As a geographer, this appears to be a location plotted at a random spot the street based on a guess by ArcGIS.

b. Exhibit 2 shows the area near that depicted in Exhibit 1, but further south on Spillway Road. Point Nos. 3 and 53 should be marked about a ½ mile further south on Spillway Road. A blue "x" shows where these locations should generally be. MCSD set its roadblocks much further south on Spillway Road to make its roadblocks more effective. Regardless, Point No. 3, which has 65 roadblocks, is assigned to Census Tract No. 301.07. Point No. 53, which had 8 roadblocks during the time period, is assigned to Census Tract No. 301.08. This does not make sense to me and suggests there is no coherent and reliable methodology for assigning roadblocks that straddle tract boundaries. These two roadblocks are at the same locations but assigned to two different census tracts by Dr. Ricchetti.

c. Exhibit 3 shows roadblock locations Nos. 141 and 215 that are both plotted on US Highway 51 near the Natchez Trace. Both of these locations are incorrectly shown to be in the middle of HWY 51. The actual physical location should be moved to near the information cabin on the Natchez Trace. The proper location for these roadblocks has been marked with a blue "x" on Exhibit 3.

d. Exhibit 4 shows roadblock locations on Highway 43 and near an entrance and exit ramp for the Natchez Trace. This exhibit shows Dr. Ricchetti's geocoded locations Nos. 14 and 203. Both of those locations are plotted in the wrong spot. The proper location for these roadblocks are shown with a blue "x." Roadblocks at this location actually cover two areas at this location, which are marked.

e. Exhibit 5 shows geocoded locations nos. 344 and 51, which are both on Yandell Road. Though both show they are on Yandell Road, they are assigned to two different census tracts. No. 344 is assigned to census tract 309. No. 51 is assigned to census tract 302.01.

f. Exhibit 6 shows numerous roadblocks on or near Yandell Road, all at the wrong location. Point Nos. 98, 100, 129, 151, 161, and 193 should be located in front of Madison Crossing Elementary School. Using Dr. Ricchetti's locations, these locations range from .15 miles to .48 miles off the actual location. The proper location for these roadblocks has been marked with a blue "x."

g. Exhibit 7 depicts a geocoded roadblock location slightly north of Canton, MS. This roadblock location is usually set up in the actual intersection, but the geocoding does not reflect the actual location. Here, Dr. Ricchetti's coordinates do not even show that we are in the actual middle of the intersection when a roadblock is actually there. Point No. 11 has 32 road blocks allocated to it according to the Compiled Unique Roadblocks. This roadblock straddles census tract 304, which is predominantly White, and census tract 305, which is predominantly Black. All of No. 11's 32 roadblocks are assigned to census tract 305.

h. Exhibit 8 shows point no 77. In reviewing these I see that this has a cleaned address as "LAKE HARBOR DRIVE AND RANKIN, MADISON COUNTY, MS." According to the MCSD, the text of the location information from the records

indicates this location is near the Reservoir, which is shown on Exhibit Nos. 1 and 2, above. If so, this location should be well to the east of the geocoded coordinates used by Dr. Ricchetti. According to MCSD, Point No. 77, as geocoded, shows this location directly behind North Park Mall, which is a couple of miles from the actual location, near Rankin County. This would be near the Reservoir on Lake Harbor near lower Spillway Road as reflected in Exhibit No 2.

i. Exhibit 9 (Figure 1)shows point No. 244 and the text of the address information from our records. The "clean address" shows the location as "OLD CANTON ROAD AND MRA, MADISON COUNTY, MS." This location should be located where there is a blue "x". This location is approximately 2.35 miles north of the actual physical location, as described in the address. Based on Dr. Ricchetti's coordinates, this roadblock location is in the city of Ridgeland. This implies that MRA, which I understand is a local private school near point No. 188, is located in the City of Ridgeland, not the City of Madison, where I understand it is actually located.

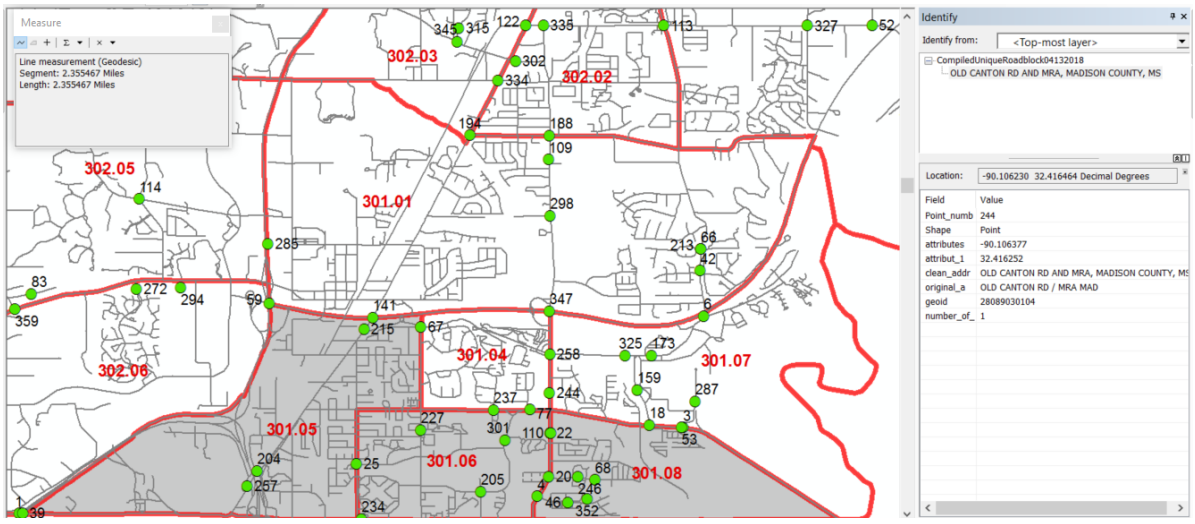

Figure 1*: Screen shot depicting 2.35 mile error from point no. 244 and MRA actually existing near point 188.*

j. Exhibit 10 shows the inherent topological error that comes with geocoding. As discussed elsewhere in this Report, this why it is critical to define your datum, your coordinate system, and project your data before conducting any geographic or geospatial analysis. This exhibit shows the inherent error that will be propagated through the entire analysis. As discussed below, the error in Dr. Ricchetti's analysis may little as 3-10 meters, 50-100 meters, or 2.35 miles, as shown in Exhibit 9.

k. Exhibit 11 shows point No. 12. Per Dr. Ricchetti's geocoded coordinates, this roadblock is located in the middle of a local wildlife refuge on a dead-end road. It has been noted on Ex 11 where the roadblock actually would be on Highway 43.

49. To geocode properly, the software needs to compute the geometry of the desired point information. If we are using hard street addresses and have performed our pre-processing

calibration, it is a relatively easy process. However, using intersection-only information introduces a variety of errors in geopositional accuracy and precision.

50. Dr. Ricchetti simply assumed that the intersection address was the proper physical address and that all the roadblocks were actually located in middle of the described intersections. (Tr. 183:7-9).

4.2 Roadblocks That Straddle Census Tracts.

51. As Dr. Ricchetti explains, he attempted to geocode roadblock locations and assign each to one of Madison County's census tracts. This poses a unique problem, as he recognized during his deposition. (Tr.178:4). Roadblocks and census tract boundaries by their very nature both occur in the middle of roads.

52. It is clear that Dr. Ricchetti's methodology did not account for this reality. Instead, in instances where a roadblock straddled two census tracts, he simply deferred to ArcGIS to assign the straddling roadblock to one of two census tracts. From his deposition, he it appears he did not recognize this until it was brought to his attention. As a geographer, I would have had to address this early on in my process.

53. Dr. Ricchetti made no effort to account for straddling roadblocks, deferring to ArcGIS to decide which census tract to assign roadblocks. Since some straddling roadblocks had numerous roadblocks at that location from 2012 through 2017, the misleading information can have profound impacts on the number of roadblocks per census tract and is not a valid representation of what actually occurred.

54. As geographer and professional in the geospatial industry, if I run into issues such as a geocoded location that straddles two or more census tracts, I develop a transparent, reliable, and repeatable methodology, perform ground truth validations on a subset of data points, and assign rules for geocoded locations that occur over two or more census tract boundaries to ensure accuracy and precision.

55. Not only did Dr. Ricchetti testify at his deposition that he did not perform this verification, he testified that he needed to do it following the deposition so he could determine the reliability of his data and his analysis. This data is the data that he already has used in his regression analysis.

56. My finding regarding straddling roadblocks assumes that Dr. Ricchetti could accurately and precisely geocode roadblock locations using intersection address information, which he could not, and shows that he still did not properly assign roadblocks to census tracts.

57. My review of the Compiled Unique Roadblock locations found that 82 of the 361 geocoded locations straddled two or more census tract. Because there were multiple roadblocks at several of these locations, these 82 locations account for 662 of the 1,843 roadblocks in the Compiled Unique Roadblock set. These locations are shown on **Figure 2**, below.

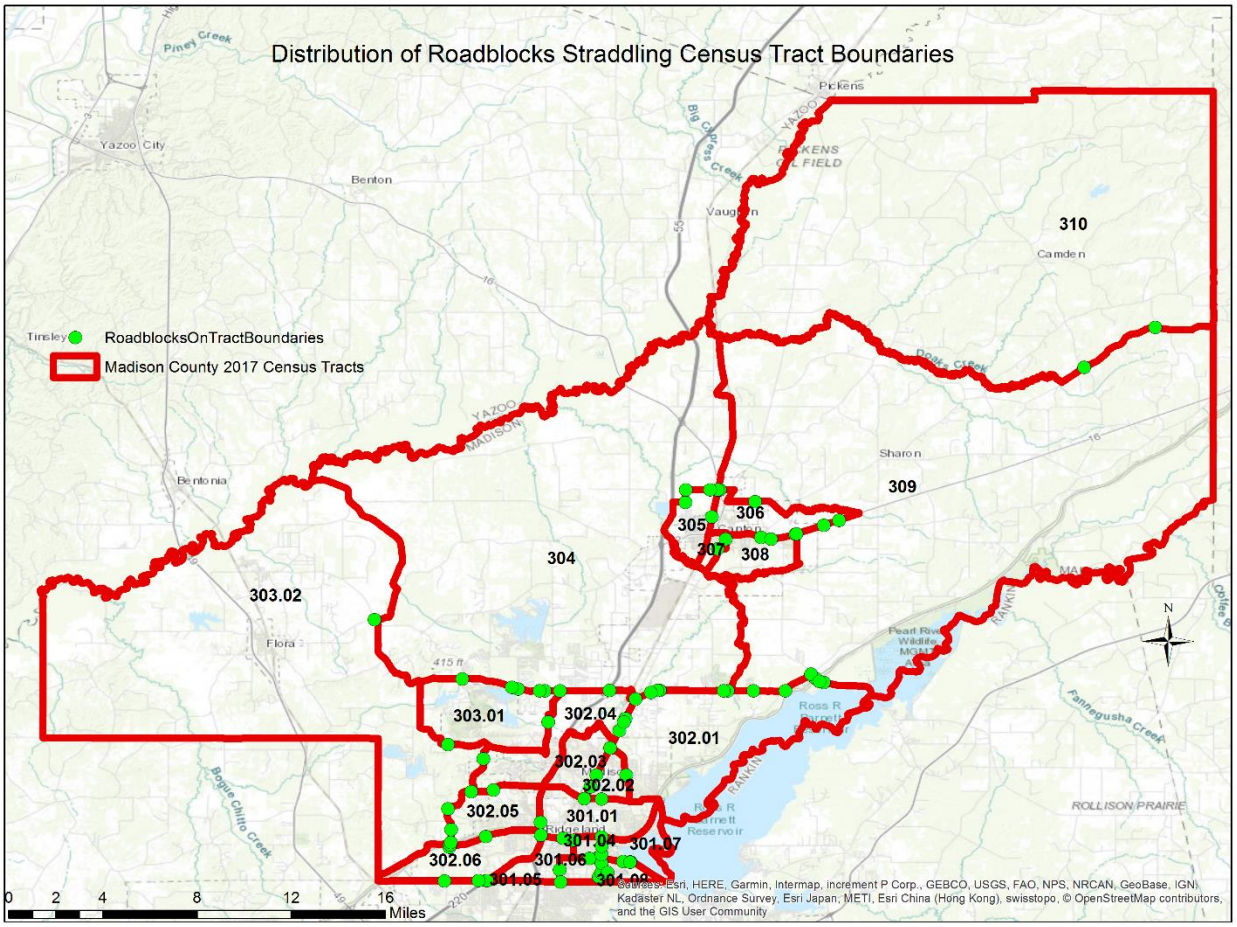

Figure *2*: This map depicts the distribution of geocoded roadblocks *from the Compiled Unique Roadblocks* that fell on census tract boundaries.

58. Approximately 23% of 361 roadblock locations straddle census tracts. Considering that several locations had multiple roadblocks located there from 2012 to 2017, 36% of 1,843 total roadblocks straddle two or more census tracts. From an analysis standpoint, that is a tremendous amount of data that should be rendered invalid.

59. Again, this finding is based on the assumption that his geocoding was done correctly, accurately, and precisely, which it was not.

4.3 Verification and Dr. Ricchetti's Match-Score Cutoff

60. Dr. Richetti testified that he did not actually perform any validation of his geocoded locations (Tr. 172:22; 173:16-23; 174:18; and 196:1). Instead, he relied on a "match score" produced by ArcGIS to rate locations. (Tr. 168:12). He claimed that if that score fell below a 90% it was excluded from his analysis. (Tr: 168:9; 177:18-22).

61. Following Geocoding, ArcGIS evaluates and scores whether the original address information "matches" the known address information for the newly geocoded location. The scoring system does not provide any assurance that the geocoded location is accurate, but rather

compares and weighs the old address information against the new. This is especially unhelpful here because 93% of the addresses only contain street intersection information. Because the "match score" does not detract for missing information when comparing original and geocoded address information, geocoding less specific address information (i.e., addresses without street numbers) will actually increase the match score. Stated differently, the match scoring system will make something less specific sound more accurate.

62. I attempted to validate his process and plotted his geocoded addresses using his match-score of greater than or equal to 90 as a cutoff.

63. Because of the lack of information about Dr. Ricchetti' s process, it is difficult to verify his methods with respect to the three sets of roadblocks he analyzed, including ones he might have disregard even if they had a match score greater than or equal to 90.

64. We are, however, able to review his methodology using his actual geocoded data and actual "match scores" that he provided.

65. Below, **Figure 3** shows the plotted locations for "1_Geographic Coordinates For CAD Addresses.csv," which is located in Dr. Ricchetti's production folder. This shows all the locations *before applying* Dr. Ricchetti's match score cutoff. These locations are plotted using Dr. Ricchetti's actual coordinates.

65.1 This file is located in his production file at "Expert Report and Production File→ Data→ Input→ Roadblock Data→ 4_geocoding_output → "1_Geographic Coordinates For CAD Addresses.csv." This file has 31,109 locations in it, which seems to be too excessive to be roadblock locations, though the folder structure suggests this is a list of roadblock locations. Regardless, this dataset contains geocoding information(X and Y coordinate) for those locations and along with match scores for each. Using this information, I am able to test Dr. Ricchetti's match score of 90 or better match to show how meaningless it is.

66. This illustrates the problem with geocoding, especially of very large data sets that do not have reliable address information. You can see that the locations are plotted all over North America, including Washington State, New York State, San Diego, and Canada. Obviously, these coordinates are not reliable locations for areas within Madison County.

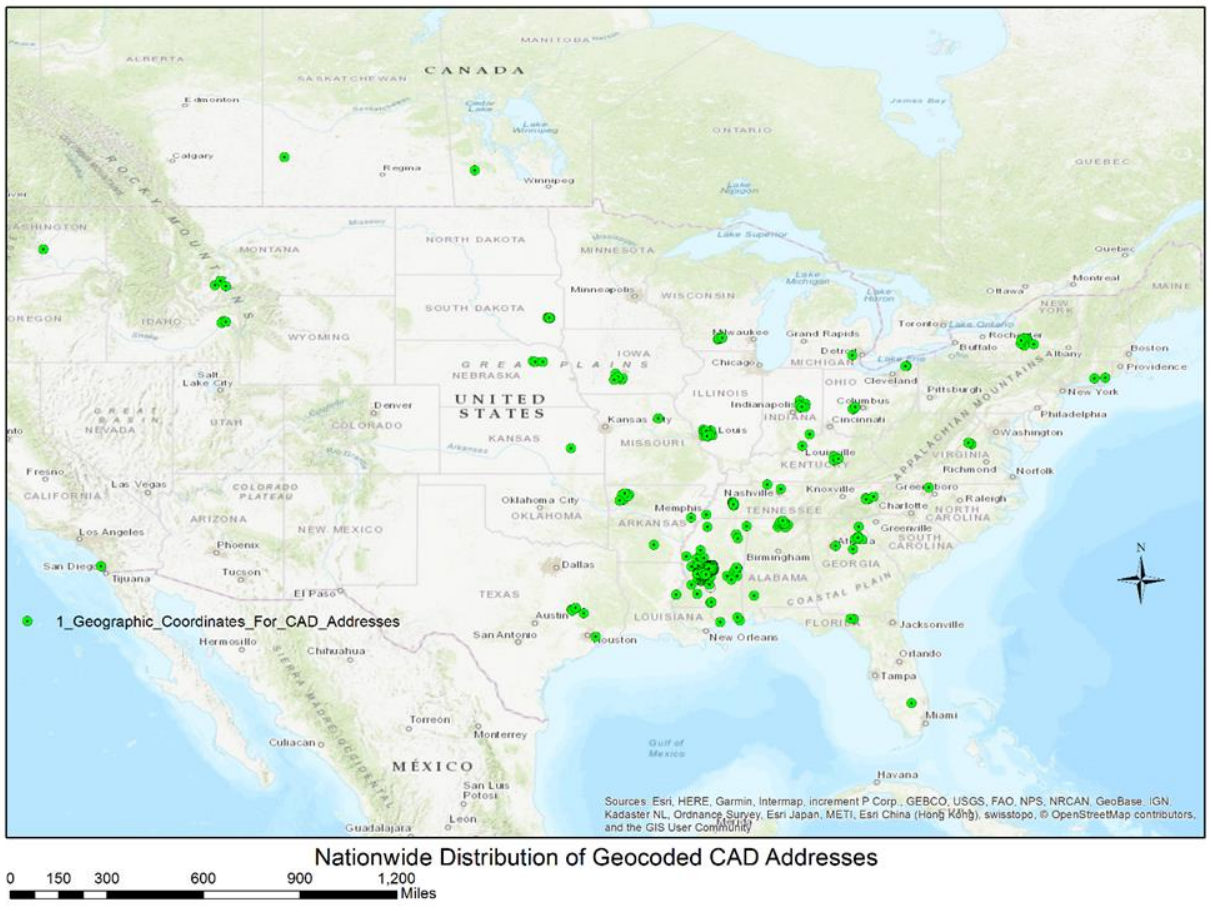

Figure 3: This map depicts the distribution of Dr. Ricchetti's Geocoded output addresses for the dataset "1_Geographic Coordinates For CAD Addresses.csv"

67. Next, I apply Dr. Ricchetti's match score of 90 or better to "improve" the locations in Madison County. According to Dr. Ricchetti, this assured better and more reliable locations. He testified that he only used locations with a match score of 90 or higher.[4]

68. As shown below in **Figure 4**, the "match score" cutoff does not provide the verification or accuracy that Dr. Ricchetti suggests. In fact, it raises serious concerns about his entire analysis since the match-score of 90 or better cutoff includes locations all over the continental United States. Certainly, geocoded locations in Wisconsin, Nebreska, Virginia, and Florida are not reliable locations for evaluating roadblocks in Madison County, Mississippi.

69. Dr. Ricchetti's report and testimony did not explain how he accounted for problematic locations that survived his match-score cutoff. Either these points were included in his analysis or he conducted some other secondary process to eliminated extreme errors. While it appears locations that show extreme error were not included in his roadblock locations, ignoring the extreme errors does not make the process or method reliable. Regardless, even throwing out the extreme errors, does not improve his data. Rather, it simply masks how unreliable its results were.

[4] Applying Dr. Ricchetti's match-score quality assurance technique, reduced the amount of geocoded locations from 31,109 to 25,335. As shown, though, we still see a national distribution of geocoded address point. Again, this national distribution would give me serious concerns regarding the reliability of my geocoded information.

The error in his remaining data is neither acknowledged or accounted for. This error would propagate itself throughout the statistical analysis of this data too.

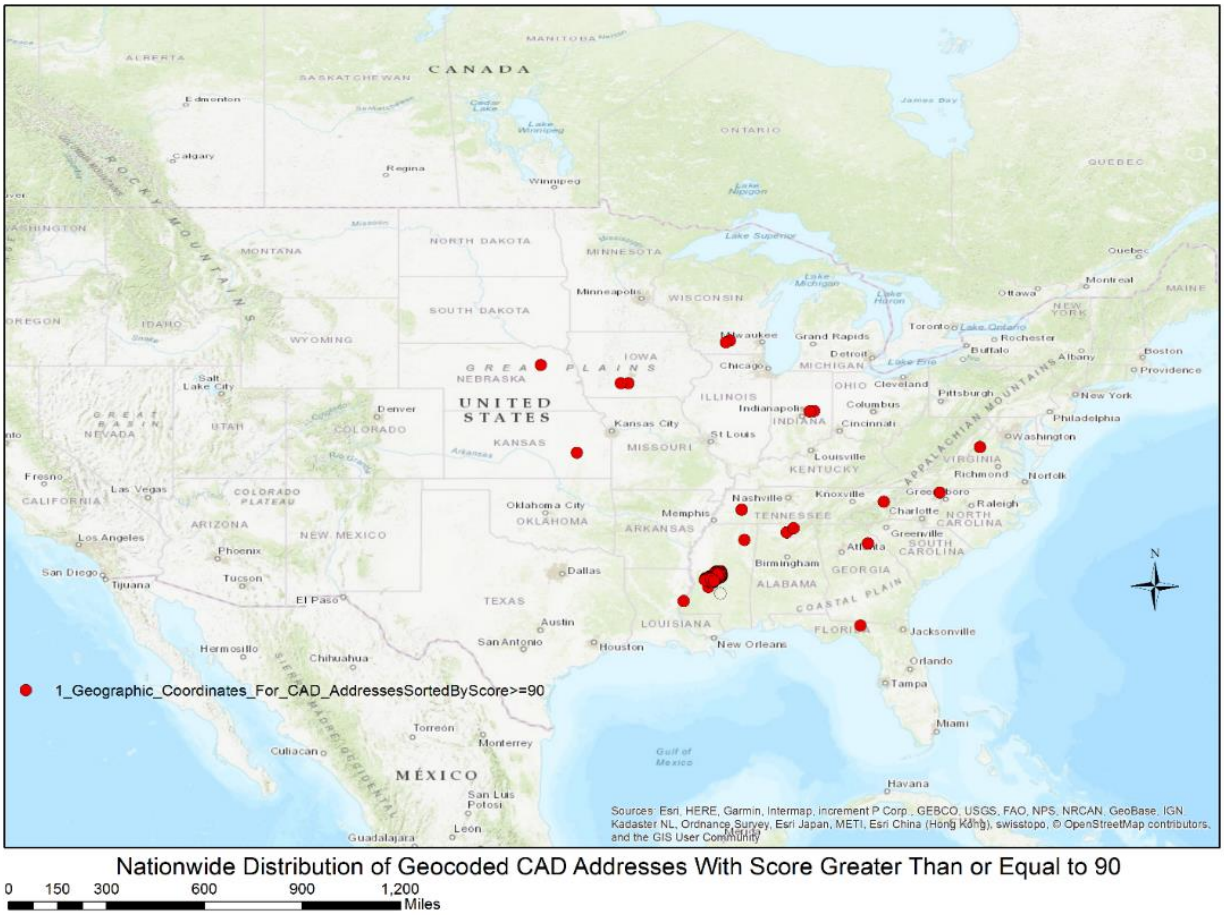

***Figure 4**: Distribution of geocoded addresses with a match score of greater than or equal to 90.*

70. It does not surprise me to see the nation-wide distribution of 25,335 geocoded points, with a match score greater than or equal to 90. As I mentioned before, this is one of the major issues with improperly geocoding address and intersection information.

4.4 Coordinate Systems

71. There are numerous obvious technical issues that Dr. Ricchetti failed or was unable to explain in his report or deposition. Even more become apparent after reviewing his data sets. From the perspective of a geographer, these technical issues may me even greater concern with the reliability and accuracy of Dr. Ricchetti's methods.

72. Defining your reference frame is the first and arguably most crucial step in all geographical analyses. This information must be pushed to all datasets used or encompassed in the analyses or there will be topological issue. If the data sets in your analyses do not have the same defined reference frame information, the resultant output will contain inherent topological errors. For example, the points will not line up with other points, points will not line up with lines, and lines will not line up with other lines.

73. From reviewing Dr. Ricchetti's production file, it is unclear what coordinate system(s) he uses. His datasets seem to use several which inherently corrupt the reliability of his geocoding findings. As a geographer, using different coordinate systems on the same project is a cardinal sin.

74. My review of Dr. Ricchetti's data shows he used several. Based on my review of his information and the multiple coordinate systems he may have used, many, if not all, of his location may be off. Depending on the situation, some may be off anywhere from as little as 3-10 meters, 50-100 meters, or even greater than the 2.35 miles as previously shown in **Figure 1**.

75. To accurately and precisely geocode coordinates, we need to know or define the reference frame we are working within, the cardinal orientation from the centroid of the intersection, and radial distance measurements to the actual position the roadblock occurred with the center of the intersection.

76. After assigning coordinates, we would need to perform ground validation and accuracy assessment of coordinate information. This would need to be done prior to performing any spatial analyses or subsequent analysis.

77. Geocoding in its most basic form is like linear algebra. For example, you are simply plotting X and Y using geographic coordinate information.

78. If person A and person B are both working in Cartesian coordinate systems, with an origin of (0,0), person A and person B can plot the points (1,1) the same way with the same geometrical measurements. If plotted individually and compared, the points and distances should be comparable. This is an example of what would be considered accurate, precise, reliable and repeatable.

79. But GIS locations can be computed different ways using different coordinate systems. If the data are not uniform this will have major impacts on performing comparable geometrical computations. If, in my example, both A and B plot using geometrical computations, then their results would be comparable, but still accurate, precise, and reliable.

80. However, if A is working in the Cartesian coordinate system and B the Polar coordinate system, you have to perform complex conversions or transformations of their results in order to make A's and B's points line up. We would be working in two different geographic spaces defined by their respective coordinate systems.

81. Furthermore, even if we are working in the same coordinate system, if our origins are not comparable then the baseline data is not comparable to the repeat data. For example, person A has a (0,0) origin and person B has (-1, -1) origin; computing the geometry of point (1,1) will be inconsistent between the two investigators.

82. Projecting the data set (as well as aforementioned initial calibration steps) is crucial to computing geometry of address information and converting it to Latitude and Longitude coordinates.

83. Projecting your data set allows you to make linear measurements or linear geometric computations on a curved surface such as the earth.

84. I know of no generally-accepted method used by geographers that would allow for an accurate and precise geocoded location using the intersection-only information provided in the CAD report.

85. Based upon the information provided in his report and my review of the datasets in his production file**,** Dr. Ricchetti did not geocode properly.

86. Given he used invalid geographic layers and coinciding datasets to build his data, Dr. Ricchetti's statistical analysis would be unreliable and invalid.

87. Basic geocoding process is built around working within a defined reference frame, which Dr. Ricchetti failed to do. Defining your reference frame entails specifying horizontal and vertical datum(s), coordinate system(s), and projection(s). Only after this is determined and set up you can reliably calculate the geometry of the respective address information. None of this is defined in provided in Dr. Richetti's datasets. This assumes, of course, that you have actual address information and not just the name of an intersection.

4.5 Other Calibration and Technical Issues

88. There are inherent issues with accuracy and precision of coordinate information when using geocoding software to obtain coordinate information. It is best practice to validate computed location through ground verification observations. Dr. Ricchetti's report does not mention of any validation process of computed geocoded coordinates nor define any datum, coordinate or projection information.

89. Notably, Dr. Ricchetti's report contained no information on how he and his team went through the address "cleaning" process. Due to this fact, we can only speculate this was done objectively.

90. His report is riddled with ambiguities and uncertainties. This puts a heavy onus on the reader and investigator to speculate as to how he performed subsequent geographic (spatial) analysis.

91. In a defined reference frame and coordinates system, calculating the geometry for singular address is relatively easy to an expert, but calculating geometry of roadblocks from street address intersection information is completely different and comes with its own special set of issues (as with most things in GIS).

5. CONCLUSION

I conclude that the geographical analyses performed by Dr. Ricchetti are invalid. Given that the geographic analyses are the premise to the statistical argument, the statistical analyses is invalid as well.

May 8, 2018

/s/ William R Funderburk
William R. Funderburk

APPENDIX A

William R. Funderburk
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Education

Master of Science, Geography — 2014
University of Southern Mississippi, Hattiesburg, MS

Bachelor of Science, Geography — 2012
University of Southern Mississippi, Long Beach, MS

2nd Bachelor of Science, Mathematics (projected completion) — 2018
University of Southern Mississippi, Long Beach, MS

Professional Work Experience

Field Applications Scientist, Gulf Coast Geospatial Center — 2017 - present
University of Southern Mississippi, Gulf Park Campus, Long Beach, MS

Research Associate, Gulf Coast Geospatial Center — 2015 – 2016
University of Southern Mississippi, Gulf Park Campus, Long Beach, MS

Graduate Research Assistant, Gulf Coast Geospatial Center — 2013 – 2014
University of Southern Mississippi, Stennis Space Center, MS

Teaching Assistant, Department of Geography and Geology — Spring 2013
University of Southern Mississippi, Hattiesburg, MS

Field Tech, Department of Geography and Geology — Dec. 2012 – Jan. 2013
University of Southern Mississippi, Gulf Park Campus, Long Beach, MS

Field Artillery (13B2P), United States Army Paratrooper — Jan. 2003 – Jan. 2007
Fort Bragg, North Carolina

Publications

Carter G. A., Anderson C. P., **Funderburk W. R.,** Jeter G. W., Otvos E.G., Lucas K. L., 2018. Catastrophic storm impact and gradual recovery in the 2005-2010, post-storm period, Mississippi-Alabama barrier islands: Variation in total and vegetated land area and relationships of ecological communities with elevation. *Geomorphology*, in revision (ref. No.: GEOMOR-7281).

Anderson C.P., Carter G.A., **Funderburk W.R**., 2016. The use of Aerial RGB imagery and LIDAR in comparing ecological habitats and geomorphic features on a natural versus man-made barrier island. *Remote Sensing*, 8 (7), 602. http://dx.doi.org/10.3390/rs8070602

Funderburk W.R., Carter G.A., Anderson C.P., 2015. Evaluating the Influence of Elevation and Impact of Hurricane Katrina on Radial Growth in Slash Pine (Pinus elliottii var. elliottii Engelm) on Cat Island, Mississippi. *Journal of Coastal Research*, 32 (3), 483-489. http://dx.doi.org/10.2112/JCOASTRES-D-15-00038.1

Funderburk W.R., 2016 COVER PHOTOGRAPH AND FRONT MATTER: INTERIOR SWALE OF THE SLOWLY-SUBSIDING CAT ISLAND, MISSISSIPPI, U.S.A. *Journal of Coastal Research*, 32, (3) pp. ii – viii. http://dx.doi.org/10.2112/1551-5036-32.3.ii

Conference Proceedings

Anderson, C. P., and **Funderburk, W. R.,** (Presenting Author) 2016. The "Cray-Z-ness" of ground returns in a *Juncus* marsh: Validating LIDAR bare elevations utilizing a real-time G.P.S network. Abstracts of the 4th Annual Mississippi Association for Spatial Technologies Meeting, October 20 – 21, 2016, Long Beach, MS.

Carter, G., C. Anderson, **Funderburk, W. R.,** (Presenting Author), G. Jeter, E. Otvos, K. Lucas, and N. Hopper. 2015. Vegetation cover and relationships of habitat-type with elevation on the Mississippi-Alabama Barrier Islands in the initial six years after Hurricane Katrina. 2015 Fall Meeting, American Geophysical Union, December 14-18, 2015, San Francisco, CA. Abstract number 81138.

Funderburk, W. R., Barrier island vegetation panel: Evaluating the influence of elevation and impact of Hurricane Katrina on radial growth in slash pine (Pinus elliottii var. elliottii Engelm.) on Cat Island, Mississippi. Abstracts of the 3rd Annual Mississippi Association for Spatial Technologies Meeting, October 22-23, 2015, Long Beach, MS.

Funderburk, W. R., and Carter, G. A. 2014. Mapping the distribution of Habitat-Types on Cat Island Mississippi. Abstracts of the 11th Annual Seven Hills Regional User Group for GIS, November 19 – 20, 2014, Tallahassee, FL.

Funderburk W.R., Carter G.A., Harley G.L., Determining Growth Response of *Pinus elliottii* to Hurricane Katrina (2005) on Cat Island Mississippi. Abstracts of the 99th Annual Ecological Society of America Meeting, August 10 – 15, 2014, Sacramento, CA.

Funderburk W.R., Carter G.A., Harley G.L., Forest Stand Dynamics on Siliciclastic, Barrier Islands: Determining Growth Responses of *Pinus elliottii* to Hurricane Katrina (2005) on Cat Island MS. American Geophysical Union Fall Meeting, San Francisco, CA, December 2013.

Funderburk, W.R., Transforming a University Campus with GIS: Creating Sustainable, Organic Permaculture, Edible Landscapes, Southeastern Division Association of American Geographers, 18 – 20 Nov. Ashville, NC. October 2012.

Selected Extramural Work and Research Projects

Assessment of crack detection in galvanized steel Davit Arms using narrow spectral band analysis and reflectance spectroscopy (Grant number-GR05975) (2018).

Establishment of a Remote Sensing Test Range at the Grand Bay National Estuarine Research Reserve (GBNERR): Phase II – including a new area of Hancock County. (Grant number-05575) (2015).

Establishment of a Remote Sensing Test Range at the Grand Bay National Estuarine Research Reserve (GBNERR): Phase I. (Grant number-GR05381) (2014).

Research and Teaching Interest

Geomatics
Geodesy
Remote Sensing
Kinematic Positioning
Physical Geography
Biogeography
Dendrochronology
Dendroecology
Coastal Systems

Teaching Experience

Adjunct Instructor, 3-D Positioning 2016-present
University of Southern Mississippi, Gulf Park

Adjunct Instructor, Remote Sensing 2016-present
University of Southern Mississippi, Gulf Park

Lab Instructor, Weather and Climate laboratory Spring 2013
University of Southern Mississippi, Hattiesburg

Volunteer Lectures and Activities

Undergraduate mentor 2015 – present

Providing local municipalities with education on geodetic / GIS / remote sensing 2015 – present
(elevation, datums, benchmarks, standards and practices)

Various guest lectures on barrier island vegetation and geomorphology 2014 – present

Various guest lectures on Remote Sensing / GPS 2013 – present

Honors and Awards

Army Commendation Medal (2)

Army Achievement Medal (2)

Certificate of Achievement

Global War on Terrorism Medal

Global Expeditionary War on Terrorism Medal

Good Conduct Medal

National Defense Medal

Expert Marksmanship Badge

Parachutists Badge

Organizations and Affiliations

United States Geospatial Intelligence Foundation (USGIF)

Mississippi Association for Spatial Technologies (MAST)

American Geophysical Union (AGU)

Ecological Society of America (ESA)

Gamma Theta Upsilon (Geographical Honors Society) (GTU)

APPENDIX B

Documents considered & Datasets Reviewed by William Funderburk

Directory Location and name: Expert Report Production File Input => Roadblock Data

"1_Master CAD Report - To Be Produced.csv"

"2_Roadblock Locations (Handwritten).xlsx"

"3_Unlisted Roadblocks.xlsx"

"1_Raw CAD Data and Clean Address Tab.xlsx"

"1_Geographic Coordinates For CAD Addresses.csv"

"2_Geographic Coordinates for Roadblock Locations (Handwritten).xlsx"

"3_Geographic Coordinates for Unlisted Roadblocks.csv"

Census tract shapefile for 2012-2017 and 2010 census block data obtained from US census bureau found at https://www.census.gov/geo/maps-data/data/tiger-line.html

Dr. Ricchetti's Report

Dr. Ricchetti's Deposition

APPENDIX C

Basic Stats on Datasets Reviewed by William Funderburk

1_Geographic_Coordinates_For_CAD_Addresses "NO SCORE"	Number of geocoded points	Percentage of total roadblocks
Locality	2185	7.02
POI	1012	3.25
PointAddress	9512	30.58
StreetAddress	4424	14.22
StreetAddressExt	408	1.31
StreetInt	8194	26.34
StreetName	5370	17.26
blank fields	4	0.01
TOTAL	31109	100.00

1_Geographic_Coordinates_For_CAD_AddressesSortedByScore>=90	number of geocoded points	Percentage of total roadblocks
Name_type	Quantity	percentage
Locality	399	1.57
POI	631	2.49
PointAddress	9471	37.38
StreetAddress	4273	16.87
StreetAddressExt	298	1.18
StreetInt	7755	30.61
StreetName	2508	9.90
TOTAL	25335	100.00

COMPILED UNIQUE ROADBLOCKS:

Dr. Ricchetti's 1,697 CAD Roadblocks and 146 "Additional Roadblocks" from Incident Reports

	attributes_x	attributes_y	clean_address	original_address	geoid	number_of_roadblocks
1	-90.17705536	32.4002533	W COUNTY LINE RD AND I-220, MADISON COUNTY, MS	W COUNTY LINE RD / I-220 RID	28089030206	114
2	-90.03243256	32.61859131	DOBSON AVE AND YANDELL AVE, MADISON COUNTY, MS	DOBSON AVE / YANDELL AVE CAN	28089030600	78
3	-90.08860779	32.41168594	LOWER SPILLWAY RD, MADISON COUNTY, MS	LOWER SPILLWAY RD RID	28089030107	65
4	-90.10803986	32.40254593	OLD CANTON RD AND PINE KNOLL DR, MADISON COUNTY, MS	OLD CANTON RD / PINE KNOLL DR RID	28089030106	59
5	-90.01618958	32.61733246	HARGON ST AND COVINGTON DR, MADISON COUNTY, MS	HARGON ST / COVINGTON DR CAN	28089030600	48
6	-90.08585358	32.42646027	POST RD AND RICE RD, MADISON COUNTY, MS	POST RD / RICE RD CAN	28089030107	44
7	-90.08901215	32.70230103	OLD YAZOO CITY RD AND HWY 16, MADISON COUNTY, MS	OLD YAZOO CITY RD / HWY 16 CAN	28089030400	39
8	-90.03372955	32.64034653	W HWY 16 AND GREEN ACRES, MADISON COUNTY, MS	W HWY 16 / GREEN ACRES CAN	28089030600	38
9	-90.02046967	32.64770889	HWY 51 AND MORGAN RD, MADISON COUNTY, MS	HWY 51 / MORGAN RD CAN	28089030900	38
10	-89.98419189	32.63393784	HWY 43 AND GOODLOE RD, MADISON COUNTY, MS	HWY 43 / GOODLOE RD CAN	28089030900	34
11	-90.03488159	32.64033508	GREEN ACRES AND RAILROAD ST, MADISON COUNTY, MS	GREEN ACRES / RAILROAD ST CAN	28089030500	32
12	-89.94761658	32.54044724	PIPELINE RD AND HWY 43, MADISON COUNTY, MS	PIPELINE RD / HWY 43 CAN	28089030900	30
13	-89.9362793	32.62942886	HWY 16 E AND SHARON RD, MADISON COUNTY, MS	HWY 16 E / SHARON RD CAN	28089030900	25
14	-89.9750061	32.52461243	HWY 43 AND NATCHEZ TRACE PKWY, MADISON COUNTY, MS	HWY 43 / NATCHEZ TRACE PKWY CAN	28089030201	25
15	-90.31687927	32.57612228	KEARNEY PARK RD AND MIDDLE RD, MADISON COUNTY, MS	KEARNEY PARK RD / MIDDLE RD FLO	28089030302	23
16	-89.99530029	32.58216858	HWY 43 AND RANKIN RD, MADISON COUNTY, MS	HWY 43 / RANKIN RD CAN	28089030900	23
17	-90.17292786	32.45587158	LAKE CASTLE RD AND RICHARDSON RD, MADISON COUNTY, MS	LAKE CASTLE RD / RICHARDSON RD CAN	28089030204	21
18	-90.09313965	32.41199875	HARBOR AND LAKE HARBOR, MADISON COUNTY, MS	HARBOR / LAKE HARBOR CAN	28089030107	20
19	-89.98714447	32.61305618	HWY 16 AND AVONDALE RD, MADISON COUNTY, MS	HWY 16 / AVONDALE RD CAN	28089030600	19
20	-90.10651398	32.40514755	OLD CANTON RD AND WILLIAM BLVD, MADISON COUNTY, MS	OLD CANTON RD / WILLIAM BLVD RID	28089030106	19
21	-90.04395294	32.58721924	HWY 51 AND CORRECTIONS DR, MADISON COUNTY, MS	HWY 51 / CORRECTIONS DR CAN	28089030400	19
22	-90.10634613	32.41098785	HARBOUR PT XING AND OLD CANTON, MADISON COUNTY, MS	HARBOUR PT XING / OLD CANTON RID	28089030106	18
23	-90.00993347	32.66199875	HWY 51 AND STUMP BRIDGE RD, MADISON COUNTY, MS	HWY 51 / STUMP BRIDGE RD CAN	28089030900	18
24	-90.34701538	32.58657074	LIVINGSTON VERNON RD AND HWY 49, MADISON COUNTY, MS	LIVINGSTON VERNON RD / HWY 49 CAN	28089030302	17
25	-90.13207245	32.4068222	TOWNE CENTER AND WHEATLEY, MADISON COUNTY, MS	TOWNE CENTER / WHEATLEY RID	28089030106	17
26	-90.03994751	32.61872864	RAILROAD ST AND GEORGE WASHINGTO, MADISON COUNTY, MS	RAILROAD ST / GEORGE WASHINGTO CAN	28089030500	16
27	-90.0069046	32.59394073	S HWY 43 AND CANTON PARKWAY, MADISON COUNTY, MS	S HWY 43 / CANTON PARKWAY CAN	28089030800	15
28	-90.05064392	32.61831284	388 RICKS DR, MADISON COUNTY, MS	388 RICKS DR CAN	28089030500	15
29	-90.21575928	32.55335999	HWY 463 AND HWY 22, MADISON COUNTY, MS	HWY 463 / HWY 22 CAN	28089030400	14
30	-90.05895233	32.60921478	W PEACE ST AND PLUMNER DR, MADISON COUNTY, MS	W PEACE ST / PLUMNER DR CAN	28089030500	14
31	-90.03977966	32.56027222	N OLD CANTON RD AND ENDRIS, MADISON COUNTY, MS	N OLD CANTON RD / ENDRIS CAN	28089030400	13
32	-90.03453064	32.62374878	N UNION ST AND MARTIN LUTHER KING, MADISON COUNTY, MS	N UNION ST / MARTIN LUTHER KING CAN	28089030600	13
33	-90.19194031	32.52423477	HWY 463 AND GLUCKSTADT RD, MADISON COUNTY, MS	HWY 463 / GLUCKSTADT RD MAD	28089030301	12
34	-89.75151062	32.76044846	HWY 43 AND CAUTHEN RD, MADISON COUNTY, MS	HWY 43 / CAUTHEN RD CAN	28089031000	12
35	-90.05486298	32.6162529	FOLEY AVE AND KING RANCH RD, MADISON COUNTY, MS	FOLEY AVE / KING RANCH RD CAN	28089030500	12
36	-90.04443359	32.61504745	MARTIN LUTHER KING DR AND N UNIO, MADISON COUNTY, MS	MARTIN LUTHER KING DR / N UNIO CAN	28089030500	11
37	-90.19989014	32.42080688	LIVINGSTON RD AND OLD AGENCY RD, MADISON COUNTY, MS	LIVINGSTON RD / OLD AGENCY RD CAN	28089030206	11
38	-90.08933258	32.60985184	VIRLILIA RD AND OLD YAZOO CITY R, MADISON COUNTY, MS	VIRLILIA RD / OLD YAZOO CITY R CAN	28089030400	11

APPENDIX D

COMPILED UNIQUE ROADBLOCKS:

Dr. Ricchetti's 1,697 CAD Roadblocks and 146 "Additional Roadblocks" from Incident Reports

	attributes_x	attributes_y	clean_address	original_address	geoid	number_of_roadblocks
39	-90.17658997	32.40026093	I-220 AND W COUNTY LINE RD, MADISON COUNTY, MS	I-220 / W COUNTY LINE RD CAN	28089030206	11
40	-89.96871185	32.84815598	HWY 51 AND HWY 17, MADISON COUNTY, MS	HWY 51 / HWY 17 CAN	28089031000	11
41	-89.94247437	32.71290207	SHARON RD AND STUMP BRIDGE RD, MADISON COUNTY, MS	SHARON RD / STUMP BRIDGE RD CAN	28089030900	11
42	-90.08634186	32.43252563	WRIGHTS MILL DR AND RICE RD, MADISON COUNTY, MS	WRIGHTS MILL DR / RICE RD MAD	28089030101	11
43	-90.18656921	32.45495224	N LIVINGSTON RD AND LAKE CASTLE RD, MADISON COUNTY, MS	N LIVINGSTON RD / LAKE CASTLE RD MAD	28089030302	10
44	-89.93623352	32.65844345	HWY 43 AND SHARON RD, MADISON COUNTY, MS	HWY 43 / SHARON RD CAN	28089030900	10
45	-90.27289581	32.49578857	ROBINSON SPRINGS RD AND POCAHONTAS, MADISON COUNTY, MS	ROBINSON SPRINGS RD / POCAHONTAS FLO	28089030302	10
46	-90.10394287	32.4017334	PINE KNOLL DR, MADISON COUNTY, MS	PINE KNOLL DR RID	28089030108	9
47	-90.04322815	32.62371826	619 MARTIN LUTHER KING DR, MADISON COUNTY, MS	619 MARTIN LUTHER KING DR CAN	28089030500	9
48	-90.07125092	32.53917694	HWY 51 AND SOWELL RD, MADISON COUNTY, MS	HWY 51 / SOWELL RD CAN	28089030400	9
49	-89.97753906	32.52706146	HWY 43 AND YANDELL RD, MADISON COUNTY, MS	HWY 43 / YANDELL RD CAN	28089030201	9
50	-90.24606323	32.56061554	LIVINGSTON VERNON RD AND STOKES, MADISON COUNTY, MS	LIVINGSTON VERNON RD / STOKES CAN	28089030302	8
51	-89.99343109	32.51694489	YANDELL RD AND TWELVE OAKS TRACE, MADISON COUNTY, MS	YANDELL RD / TWELVE OAKS TRACE CAN	28089030201	8
52	-90.06342316	32.46509552	HOY RD AND OLD RICE RD, MADISON COUNTY, MS	HOY RD / OLD RICE RD MAD	28089030201	8
53	-90.0888443	32.4116745	SPILLWAY RD AND BREAKERS LN, MADISON COUNTY, MS	SPILLWAY RD / BREAKERS LN RID	28089030108	8
54	-90.04675293	32.6185379	BOYD ST AND GEORGE WASHINGTON AV, MADISON COUNTY, MS	BOYD ST / GEORGE WASHINGTON AV CAN	28089030500	8
55	-90.037323	32.62368774	JAMES ST AND MARTIN LUTHER KING, MADISON COUNTY, MS	JAMES ST / MARTIN LUTHER KING CAN	28089030600	8
56	-90.00255585	32.69113922	HWY 51 AND DAVIS CROSSING, MADISON COUNTY, MS	HWY 51 / DAVIS CROSSING CAN	28089030900	7
57	-90.13653564	32.58304977	HWY 22 AND CATLETT RD, MADISON COUNTY, MS	HWY 22 / CATLETT RD CAN	28089030400	7
58	-89.99523163	32.5603714	HWY 43 AND ENDRIS RD, MADISON COUNTY, MS	HWY 43 / ENDRIS RD CAN	28089030900	7
59	-90.14375305	32.42818069	NATCHEZ TRACE PKWY AND I-55, MADISON COUNTY, MS	NATCHEZ TRACE PKWY / I-55 RID	28089030105	7
60	-90.05764008	32.472332	OLD RICE RD AND SHADOW HILL DR, MADISON COUNTY, MS	OLD RICE RD / SHADOW HILL DR CAN	28089030201	7
61	-90.03805542	32.51933289	OLD CANTON RD AND YANDELL RD, MADISON COUNTY, MS	OLD CANTON RD / YANDELL RD CAN	28089030400	7
62	-90.0486145	32.58060455	HWY 51 AND NISSAN PKWY, MADISON COUNTY, MS	HWY 51 / NISSAN PKWY CAN	28089030400	7
63	-90.17767334	32.53667068	124 N I-55, MADISON COUNTY, MS	124 N I-55 CAN	28089030400	7
64	-90.20085907	32.44431686	LAKE CAVALIER RD AND N LIVINGSTO, MADISON COUNTY, MS	LAKE CAVALIER RD / N LIVINGSTO MAD	28089030302	7
65	-90.30366516	32.51155472	HWY 49 AND PETRIFIED FOREST RD, MADISON COUNTY, MS	HWY 49 / PETRIFIED FOREST RD CAN	28089030302	6
66	-90.08623505	32.4353714	BREEZY HILL DR AND RICE RD, MADISON COUNTY, MS	BREEZY HILL DR / RICE RD MAD	28089030101	6
67	-90.1235199	32.42500305	RICE RD AND PEAR ORCHARD RD, MADISON COUNTY, MS	RICE RD / PEAR ORCHARD RD RID	28089030104	6
68	-90.10031128	32.40473175	WILLIAM BLVD, MADISON COUNTY, MS	WILLIAM BLVD CAN	28089030108	6
69	-90.04859161	32.62272263	HOLMES AVE AND MACE ST, MADISON COUNTY, MS	HOLMES AVE / MACE ST CAN	28089030500	6
70	-90.3325119	32.57169342	HWY 49 AND MIDDLE RD, MADISON COUNTY, MS	HWY 49 / MIDDLE RD CAN	28089030302	6
71	-89.99081421	32.74888611	HWY 51 AND WAY RD, MADISON COUNTY, MS	HWY 51 / WAY RD CAN	28089031000	6
72	-90.03845215	32.62369537	RAILROAD ST AND MARTIN LUTHER KI, MADISON COUNTY, MS	RAILROAD ST / MARTIN LUTHER KI CAN	28089030500	6
73	-90.03852844	32.62369537	MARTIN LUTHER KING DR AND RAILRO, MADISON COUNTY, MS	MARTIN LUTHER KING DR / RAILRO CAN	28089030500	6
74	-90.03063965	32.62255859	RICHARD CIR, MADISON COUNTY, MS	RICHARD CIR CAN	28089030600	5
75	-89.87284088	32.69706345	HWY 43 AND SULPHUR SPRINGS RD, MADISON COUNTY, MS	HWY 43 / SULPHUR SPRINGS RD CAN	28089030900	5
76	-90.13625336	32.55327988	STOUT RD AND CATLETT RD, MADISON COUNTY, MS	STOUT RD / CATLETT RD CAN	28089030400	5

APPENDIX D

COMPILED UNIQUE ROADBLOCKS:

Dr. Ricchetti's 1,697 CAD Roadblocks and 146 "Additional Roadblocks" from Incident Reports

	attributes_x	attributes_y	clean_address	original_address	geoid	number_of_roadblocks
77	-90.10901642	32.41405106	LAKE HARBOUR DRIVE AND RANKIN, MADISON COUNTY, MS	Lake Harbour Drive / Rankin	28089030104	5
78	-90.08938599	32.59406662	OLD JACKSON RD AND HWY 22, MADISON COUNTY, MS	OLD JACKSON RD / HWY 22 CAN	28089030400	5
79	-90.02677917	32.6385994	RR AND GREEN ACRES, MADISON COUNTY, MS	RR / GREEN ACRES CAN	28089030600	5
80	-90.15769196	32.51791	GLUCKSTADT RD AND DEWEES RD, MADISON COUNTY, MS	GLUCKSTADT RD / DEWEES RD CAN	28089030301	5
81	-90.09997559	32.58411407	HWY 22 AND CALHOUN PKWY, MADISON COUNTY, MS	HWY 22 / CALHOUN PKWY CAN	28089030400	5
82	-90.04470825	32.58623886	2935 HWY 51, MADISON COUNTY, MS	2935 HWY 51 CAN	28089030400	5
83	-90.17539978	32.42944717	122 NATCHEZ TRACE PKWY, MADISON COUNTY, MS	122 NATCHEZ TRACE PKWY CAN	28089030205	5
84	-89.90604401	32.63900375	HWY 16 AND RATLIFF FERRY RD, MADISON COUNTY, MS	HWY 16 / RATLIFF FERRY RD CAN	28089030900	5
85	-89.8094635	32.7156105	HWY 17 AND SULPHUR SPRINGS RD, MADISON COUNTY, MS	HWY 17 / SULPHUR SPRINGS RD CAN	28089031000	5
86	-90.36658478	32.49875641	HWY 22 AND SPRING CREEK RD, MADISON COUNTY, MS	HWY 22 / SPRING CREEK RD CAN	28089030302	5
87	-90.04675293	32.61502075	BOYD ST AND WEST NORTH, MADISON COUNTY, MS	BOYD ST / WEST NORTH CAN	28089030500	5
88	-90.30413818	32.54594421	HWY 22 AND BANNERMAN DR, MADISON COUNTY, MS	HWY 22 / BANNERMAN DR FLO	28089030302	5
89	-90.13199615	32.51691818	GLUCKSTADT RD AND CATLETT RD, MADISON COUNTY, MS	GLUCKSTADT RD / CATLETT RD CAN	28089030400	4
90	-90.09339142	32.58893585	NISSAN PKWY AND HWY 22, MADISON COUNTY, MS	NISSAN PKWY / HWY 22 CAN	28089030400	4
91	-90.04230499	32.61014938	CANAL ST AND W ACADEMY ST, MADISON COUNTY, MS	CANAL ST / W ACADEMY ST CAN	28089030500	4
92	-90.08905029	32.54971313	OLD JACKSON RD AND I-55, MADISON COUNTY, MS	OLD JACKSON RD / I-55 MAD	28089030400	4
93	-90.03762817	32.62757874	RAILROAD ST, MADISON COUNTY, MS	RAILROAD ST CAN	28089030500	4
94	-90.04049683	32.4914856	N OLD CANTON RD AND DAVE BROWN RD, MADISON COUNTY, MS	N OLD CANTON RD / DAVE BROWN RD CAN	28089030201	4
95	-89.83875275	32.7822113	LORING RD AND HWY 17, MADISON COUNTY, MS	LORING RD / HWY 17 CAN	28089031000	4
96	-90.04421997	32.62126541	MLK AND ADELINE ST, MADISON COUNTY, MS	MLK / ADELINE ST CAN	28089030500	4
97	-89.82128906	32.74313354	HWY 17 AND HWY 43, MADISON COUNTY, MS	HWY 17 / HWY 43 CAN	28089031000	4
98	-90.07178497	32.51709747	YANDELL RD AND CLARKDELL RD, MADISON COUNTY, MS	YANDELL RD / CLARKDELL RD CAN	28089030400	4
99	-90.30883026	32.54263687	RAILROAD AV AND CMU, MADISON COUNTY, MS	RAILROAD AV / CMU CAN	28089030302	4
100	-90.07054138	32.51710892	YANDELL RD AND MADISON CROSSING, MADISON COUNTY, MS	YANDELL RD / MADISON CROSSING MAD	28089030400	4
101	-90.18199921	32.40019989	W COUNTY LINE AND HIGHLAND COLONY, MADISON COUNTY, MS	W COUNTY LINE / HIGHLAND COLONY CAN	28089030206	4
102	-90.04026794	32.61505508	RAILROAD ST AND W NORTH ST, MADISON COUNTY, MS	RAILROAD ST / W NORTH ST CAN	28089030500	4
103	-90.0442276	32.61856461	GEORGE WASHINGTON AVE AND KING R, MADISON COUNTY, MS	GEORGE WASHINGTON AVE / KING R CAN	28089030500	4
104	-90.03175354	32.62266159	RICHARD CIR AND DOBSON AVE, MADISON COUNTY, MS	RICHARD CIR / DOBSON AVE CAN	28089030600	4
105	-89.98655701	32.77806473	HWY 51 AND LORING RD, MADISON COUNTY, MS	HWY 51 / LORING RD CAN	28089031000	4
106	-90.03939819	32.6113472	CAMERON ST AND W FULTON ST, MADISON COUNTY, MS	CAMERON ST / W FULTON ST CAN	28089030700	4
107	-89.76596069	32.74020004	SULPHUR SPRING RD AND GIN RD, MADISON COUNTY, MS	SULPHUR SPRING RD / GIN RD CAN	28089030900	4
108	-90.09546661	32.49241257	HWY 51 AND GREEN OAK LN, MADISON COUNTY, MS	HWY 51 / GREEN OAK LN CAN	28089030204	4
109	-90.10649109	32.44726944	OLD CANTON RD AND CALUMET DR, MADISON COUNTY, MS	OLD CANTON RD / CALUMET DR CAN	28089030101	4
110	-90.10624695	32.41098785	HARBOUR POINTE CROSSING AND NORT, MADISON COUNTY, MS	HARBOUR POINTE CROSSING / NORT RID	28089030108	4
111	-90.26583862	32.55144119	HWY 22 AND ANDOVER DR, MADISON COUNTY, MS	HWY 22 / ANDOVER DR CAN	28089030302	4
112	-90.28811646	32.58969116	LIVINGSTON VERNON RD AND ST CHAR, MADISON COUNTY, MS	LIVINGSTON VERNON RD / ST CHAR FLO	28089030302	3
113	-90.09117126	32.46505356	HOY RD AND RICE RD, MADISON COUNTY, MS	HOY RD / RICE RD MAD	28089030202	3
114	-90.16107941	32.44203186	STEED RD AND RICHARDSON RD, MADISON COUNTY, MS	STEED RD / RICHARDSON RD CAN	28089030205	3

APPENDIX D

COMPILED UNIQUE ROADBLOCKS:

Dr. Ricchetti's 1,697 CAD Roadblocks and 146 "Additional Roadblocks" from Incident Reports

	attributes_x	attributes_y	clean_address	original_address	geoid	number_of_roadblocks
115	-90.01182556	32.63319778	FINNEY RD AND MORGAN RD, MADISON COUNTY, MS	FINNEY RD / MORGAN RD CAN	28089030600	3
116	-89.93619537	32.6185112	ROBINSON RD AND SHARON RD, MADISON COUNTY, MS	ROBINSON RD / SHARON RD CAN	28089030900	3
117	-90.18070984	32.49436569	REUNION PKWY AND HWY 463, MADISON COUNTY, MS	REUNION PKWY / HWY 463 MAD	28089030301	3
118	-90.200737	32.4839325	ROBINSON SPRINGS RD AND POC, MADISON COUNTY, MS	ROBINSON SPRINGS RD / POC CAN	28089030302	3
119	-90.03203583	32.63382339	1415 W HWY 16, MADISON COUNTY, MS	1415 W HWY 16 CAN	28089030600	3
120	-90.19274139	32.5337944	HWY 463 AND STRIBLING RD, MADISON COUNTY, MS	HWY 463 / STRIBLING RD MAD	28089030400	3
121	-90.02981567	32.63196564	W HWY 16 AND HWY 51, MADISON COUNTY, MS	W HWY 16 / HWY 51 CAN	28089030600	3
122	-90.10951996	32.46508789	HWY 463 AND MADISON MIDDLE, MADISON COUNTY, MS	HWY 463 / MADISON MIDDLE CAN	28089030203	3
123	-90.04636383	32.62124634	ADELINE ST AND SINGLETON ST, MADISON COUNTY, MS	ADELINE ST / SINGLETON ST CAN	28089030500	3
124	-89.96963501	32.52200317	HWY 43 AND TURCOTTE LAB DR, MADISON COUNTY, MS	HWY 43 / TURCOTTE LAB DR CAN	28089030900	3
125	-89.76803589	32.75790405	HWY 43 AND GIN RD, MADISON COUNTY, MS	HWY 43 / GIN RD CAR	28089031000	3
126	-90.04845428	32.58081055	HWY 51 AND HWY 16 W, MADISON COUNTY, MS	HWY 51 / HWY 16 W CAN	28089030400	3
127	-90.07056427	32.51711655	300 YANDELL RD, MADISON COUNTY, MS	300 YANDELL RD CAN	28089030400	3
128	-90.03488922	32.61563873	HWY 16 AND HWY 51, MADISON COUNTY, MS	HWY 16 / HWY 51 CAN	28089030600	3
129	-90.05050659	32.54238892	SMITH CARR AND E SOWELL RD, MADISON COUNTY, MS	SMITH CARR / E SOWELL RD CAN	28089030400	3
130	-90.28852081	32.51951981	POCAHONTAS RD AND MT LEOPARD RD, MADISON COUNTY, MS	POCAHONTAS RD / MT LEOPARD RD FLO	28089030302	3
131	-90.04566193	32.61855698	GEORGE WASHINGTON AVE AND RR, MADISON COUNTY, MS	GEORGE WASHINGTON AVE / RR CAN	28089030500	3
132	-90.02170563	32.6230278	INDUSTRIAL DR AND MATTHEWS AVE, MADISON COUNTY, MS	INDUSTRIAL DR / MATTHEWS AVE CAN	28089030600	3
133	-90.18177032	32.40090942	HIGHLAND COLONY PKWY, MADISON COUNTY, MS	HIGHLAND COLONY PKWY MAD	28089030206	3
134	-90.05478668	32.62356186	HOLMES AVE AND KING RANCH RD, MADISON COUNTY, MS	HOLMES AVE / KING RANCH RD CAN	28089030500	3
135	-90.31085968	32.58965683	LIVINGSTON VERNON RD AND HARRIS, MADISON COUNTY, MS	LIVINGSTON VERNON RD / HARRIS FLO	28089030302	3
136	-90.03755951	32.69113922	WAY RD AND DAVIS CROSSING RD, MADISON COUNTY, MS	WAY RD / DAVIS CROSSING RD CAN	28089030400	3
137	-90.02915192	32.62176132	WILSON ST AND RICHARD CIR, MADISON COUNTY, MS	WILSON ST / RICHARD CIR CAN	28089030600	3
138	-89.83577728	32.6610527	HWY 16 EAST AND PAT LUCKETT RD, MADISON COUNTY, MS	HWY 16 EAST / PAT LUCKETT RD CAN	28089030900	2
139	-90.20282745	32.40014267	N LIVINGSTON RD AND COUNTY LINE, MADISON COUNTY, MS	N LIVINGSTON RD / COUNTY LINE CAN	28089030206	2
140	-89.74710083	32.67307663	WALNUT RD AND NATCHEZ TRACE PKWY, MADISON COUNTY, MS	WALNUT RD / NATCHEZ TRACE PKWY CAN	28089030900	2
141	-90.12995911	32.42630768	HWY 51 AND NATCHEZ TRACE, MADISON COUNTY, MS	HWY 51 / NATCHEZ TRACE RID	28089030101	2
142	-90.05891418	32.67737961	N HWY 55 AND 124, MADISON COUNTY, MS	N HWY 55 / 124 CAN	28089030400	2
143	-90.06362915	32.58545303	NISSAN PKWY AND NISSAN DR, MADISON COUNTY, MS	NISSAN PKWY / NISSAN DR CAN	28089030400	2
144	-90.03809357	32.52589035	OLD CANTON RD AND HARVEY CROSSIN, MADISON COUNTY, MS	OLD CANTON RD / HARVEY CROSSIN CAN	28089030400	2
145	-89.87010193	32.69685745	SULPHUR SPRINGS RD AND POTLUCK R, MADISON COUNTY, MS	SULPHUR SPRINGS RD / POTLUCK R CAN	28089030900	2
146	-90.0400238	32.61634064	RAILROAD ST AND BOWMAN ST, MADISON COUNTY, MS	RAILROAD ST / BOWMAN ST CAN	28089030500	2
147	-89.99324036	32.53899765	HWY 43 AND COTTON BLOSSOM RD, MADISON COUNTY, MS	HWY 43 / COTTON BLOSSOM RD CAN	28089030900	2
148	-89.85848236	32.60366058	RATLIFF FERRY RD AND BOYD DR, MADISON COUNTY, MS	RATLIFF FERRY RD / BOYD DR CAN	28089030900	2
149	-90.04962158	32.6243515	707 MACE ST, MADISON COUNTY, MS	707 MACE ST CAN	28089030500	2
150	-90.07274628	32.48779678	CLARKDELL RD AND GREEN OAK LN, MADISON COUNTY, MS	CLARKDELL RD / GREEN OAK LN CAN	28089030201	2
151	-90.072052	32.51708221	YANDELL RD AND BRACEY RD, MADISON COUNTY, MS	YANDELL RD / BRACEY RD CAN	28089030400	2
152	-90.08808136	32.54776382	NISSAN DR AND OLD JACKSON RD, MADISON COUNTY, MS	NISSAN DR / OLD JACKSON RD CAN	28089030400	2

APPENDIX D

COMPILED UNIQUE ROADBLOCKS:

Dr. Ricchetti's 1,697 CAD Roadblocks and 146 "Additional Roadblocks" from Incident Reports

	attributes_x	attributes_y	clean_address	original_address	geoid	number_of_roadblocks
153	-90.05884552	32.56297302	HWY 51 AND LINKS DR, MADISON COUNTY, MS	HWY 51 / LINKS DR CAN	28089030400	2
154	-90.19945526	32.42228317	N LIVINGSTON RD AND NATCHEZ TRACE BRIDGE, MADISON COUNTY, MS	N LIVINGSTON RD / NATCHEZ TRACE BRIDGE MAD	28089030206	2
155	-90.17494202	32.56565475	MCMILLON RD AND HWY 22, MADISON COUNTY, MS	MCMILLON RD / HWY 22 MAD	28089030400	2
156	-90.07836914	32.54092026	SOWELL RD AND SOWELL RD, MADISON COUNTY, MS	SOWELL RD / SOWELL RD MAD	28089030400	2
157	-89.96032715	32.62166977	E HWY 16 AND ROYAL OAK RD, MADISON COUNTY, MS	E HWY 16 / ROYAL OAK RD CAN	28089030600	2
158	-90.029953	32.61016083	ACADEMY ST AND LYON ST, MADISON COUNTY, MS	ACADEMY ST / LYON ST CAN	28089030800	2
159	-90.0947113	32.41666031	HARBOR DR, MADISON COUNTY, MS	HARBOR DR CAN	28089030107	2
160	-90.22270203	32.43442917	GREENS CROSSING RD, MADISON COUNTY, MS	GREENS CROSSING RD MAD	28089030302	2
161	-90.07616425	32.51581192	YANDELL RD AND CLARKDELL RD EXT, MADISON COUNTY, MS	YANDELL RD / CLARKDELL RD EXT CAN	28089030400	2
162	-90.0364151	32.60405731	UNION ST AND W DINKINS ST, MADISON COUNTY, MS	UNION ST / W DINKINS ST CAN	28089030700	2
163	-90.33125305	32.53838348	HWY 22 AND CHILDRESS LN, MADISON COUNTY, MS	HWY 22 / CHILDRESS LN CAN	28089030302	2
164	-90.22629547	32.47418594	COKER RD AND LAKE CAVALIER RD, MADISON COUNTY, MS	COKER RD / LAKE CAVALIER RD MAD	28089030302	2
165	-89.9838028	32.79603577	HWY 51 AND 2 J'S, MADISON COUNTY, MS	HWY 51 / 2 J'S CAN	28089031000	2
166	-90.03491211	32.60403824	S LIBERTY ST AND W DINKINS ST, MADISON COUNTY, MS	S LIBERTY ST / W DINKINS ST CAN	28089030700	2
167	-90.05690765	32.68186188	W HWY 16 AND I-55, MADISON COUNTY, MS	W HWY 16 / I-55 CAN	28089030400	2
168	-90.05068207	32.60635376	WESTSIDE DR AND ROSEBUD DR, MADISON COUNTY, MS	WESTSIDE DR / ROSEBUD DR CAN	28089030500	2
169	-90.08909607	32.55703354	OLD JACKSON RD AND STOUT RD, MADISON COUNTY, MS	OLD JACKSON RD / STOUT RD CAN	28089030400	2
170	-90.05153656	32.62368774	1106 HOLMES AV, MADISON COUNTY, MS	1106 HOLMES AV CAN	28089030500	2
171	-89.90175629	32.6204567	RATLIFF FERRY RD AND ROBINSON RD, MADISON COUNTY, MS	RATLIFF FERRY RD / ROBINSON RD CAN	28089030900	2
172	-90.08938599	32.5393219	W SOWELL RD AND OLD JACKSON RD, MADISON COUNTY, MS	W SOWELL RD / OLD JACKSON RD CAN	28089030400	2
173	-90.09276581	32.42120743	831 RICE RD, MADISON COUNTY, MS	831 RICE RD RID	28089030107	2
174	-90.03481293	32.61856461	YANDELL AVE AND N LIBERTY ST, MADISON COUNTY, MS	YANDELL AVE / N LIBERTY ST CAN	28089030600	2
175	-90.02471161	32.62008667	INDUSTRIAL DR AND LINCOLN ST, MADISON COUNTY, MS	INDUSTRIAL DR / LINCOLN ST CAN	28089030600	2
176	-90.08908081	32.64042664	HEINDL RD AND OLD YAZOO CITY RD, MADISON COUNTY, MS	HEINDL RD / OLD YAZOO CITY RD CAN	28089030400	2
177	-90.13915253	32.49761581	BOZEMAN RD AND REUNION ANNANDALE, MADISON COUNTY, MS	BOZEMAN RD / REUNION ANNANDALE CAN	28089030301	2
178	-90.04214478	32.61341858	N CANAL ST AND FRANKLIN ST, MADISON COUNTY, MS	N CANAL ST / FRANKLIN ST CAN	28089030500	2
179	-90.00770569	32.60390472	HWY 43 AND DINKINS ST, MADISON COUNTY, MS	HWY 43 / DINKINS ST CAN	28089030800	2
180	-90.05139923	32.62360001	HOLMES AV, MADISON COUNTY, MS	HOLMES AV CAN	28089030500	2
181	-90.0555191	32.62804031	DORIS FRANCIS BLVD AND HARRINGTO, MADISON COUNTY, MS	DORIS FRANCIS BLVD / HARRINGTO CAN	28089030500	2
182	-90.02713013	32.61854553	LINCOLN ST AND YANDELL AVE, MADISON COUNTY, MS	LINCOLN ST / YANDELL AVE CAN	28089030600	2
183	-90.1570816	32.4787941	HWY 463 AND MANNSDALE, MADISON COUNTY, MS	HWY 463 / MANNSDALE CAN	28089030204	2
184	-90.08881378	32.5850029	NISSAN PKWY AND OLD JACKSON RD, MADISON COUNTY, MS	NISSAN PKWY / OLD JACKSON RD CAN	28089030400	2
185	-90.39897156	32.54275894	COX FERRY RD AND PHILLIPS RD, MADISON COUNTY, MS	COX FERRY RD / PHILLIPS RD CAN	28089030302	1
186	-90.06362915	32.5854454	NISSAN DR AND NISSAN PKWY, MADISON COUNTY, MS	NISSAN DR / NISSAN PKWY CAN	28089030400	1
187	-90.09473419	32.54017639	SOWELL RD AND I-55, MADISON COUNTY, MS	SOWELL RD / I-55 MAD	28089030400	1
188	-90.10643768	32.45043564	OLD CANTON RD AND ST AUGUSTINE D, MADISON COUNTY, MS	OLD CANTON RD / ST AUGUSTINE D MAD	28089030101	1
189	-90.19879913	32.43163681	N LIVINGSTON RD AND COU, MADISON COUNTY, MS	N LIVINGSTON RD / COU CAN	28089030302	1
190	-90.08906555	32.57499695	OLD JACKSON RD AND BEAL RD, MADISON COUNTY, MS	OLD JACKSON RD / BEAL RD CAN	28089030400	1

APPENDIX D

COMPILED UNIQUE ROADBLOCKS:

Dr. Ricchetti's 1,697 CAD Roadblocks and 146 "Additional Roadblocks" from Incident Reports

	attributes_x	attributes_y	clean_address	original_address	geoid	number_of_roadblocks
191	-90.10414886	32.506073	PARKWAY EAST AND INDUSTRIAL DR S, MADISON COUNTY, MS	PARKWAY EAST / INDUSTRIAL DR S MAD	28089030204	1
192	-89.85935974	32.6529541	E HWY 16 AND HOGUE RD, MADISON COUNTY, MS	E HWY 16 / HOGUE RD CAN	28089030900	1
193	-90.07460022	32.51259613	CLARKDELL RD EXT AND YAN, MADISON COUNTY, MS	CLARKDELL RD EXT / YAN CAN	28089030201	1
194	-90.11701202	32.45050812	HWY 51 AND ST AUGUSTINE DR, MADISON COUNTY, MS	HWY 51 / ST AUGUSTINE DR MAD	28089030101	1
195	-90.0770874	32.54249954	W SOWELL RD AND RR TRACKS, MADISON COUNTY, MS	W SOWELL RD / RR TRACKS MAD	28089030400	1
196	-90.16146851	32.51902771	463 AND GLUCKSTADT RD, MADISON COUNTY, MS	463 / GLUCKSTADT RD CAN	28089030301	1
197	-90.05438232	32.6162529	FOLEY AVE AND SUNSET AVE, MADISON COUNTY, MS	FOLEY AVE / SUNSET AVE CAN	28089030500	1
198	-90.03640747	32.60582352	S UNION ST AND CAR WASH, MADISON COUNTY, MS	S UNION ST / CAR WASH CAN	28089030700	1
199	-90.05147552	32.56248474	147 LINKS DR, MADISON COUNTY, MS	147 LINKS DR CAN	28089030400	1
200	-89.84157562	32.62989426	MIGGINS RD AND ROBINSON RD, MADISON COUNTY, MS	MIGGINS RD / ROBINSON RD CAN	28089030900	1
201	-90.03670502	32.64455032	130 JOHNSON HILL RD, MADISON COUNTY, MS	130 Johnson Hill Rd	28089030400	1
202	-90.30957031	32.54311752	KEARNEY PARK RD AND HWY 22, MADISON COUNTY, MS	KEARNEY PARK RD / HWY 22 CAN	28089030302	1
203	-89.97251129	32.52275848	HWY 43 AND BROWNS LANDING RD, MADISON COUNTY, MS	HWY 43 / BROWNS LANDING RD CAN	28089030201	1
204	-90.14530182	32.40590668	HWY 51 HWY 17, MADISON COUNTY, MS	HWY 51 HWY 17 CAN	28089030105	1
205	-90.11557007	32.40314865	NORTHPARK DR AND AVERY BLVD, MADISON COUNTY, MS	NORTHPARK DR / AVERY BLVD RID	28089030106	1
206	-90.04945374	32.61852646	RR AND GEORGE WASHINGTON, MADISON COUNTY, MS	RR / GEORGE WASHINGTON CAN	28089030500	1
207	-89.98095703	32.53079605	HWY 43 AND RAMAGE RD, MADISON COUNTY, MS	HWY 43 / RAMAGE RD CAN	28089030900	1
208	-90.02631378	32.60898972	ADAMS STREET AND PEAR STREET, MADISON COUNTY, MS	Adams Street / Pear Street	28089030800	1
209	-90.02433777	32.6200943	INDUSTRIAL DR AND MILLER ST, MADISON COUNTY, MS	INDUSTRIAL DR / MILLER ST CAN	28089030600	1
210	-90.14375305	32.54634857	CAROLINE BLVD AND BELLEVUE DR, MADISON COUNTY, MS	CAROLINE BLVD / BELLEVUE DR CAN	28089030400	1
211	-90.05475616	32.63266754	HEINDL RD AND KING RANCH RD, MADISON COUNTY, MS	HEINDL RD / KING RANCH RD CAN	28089030500	1
212	-90.05071259	32.61851883	GEORGE WASHINGTON AVE AND RICKS, MADISON COUNTY, MS	GEORGE WASHINGTON AVE / RICKS CAN	28089030500	1
213	-90.08623505	32.43535995	RICE AND WOODS CROSSING BLVD, MADISON COUNTY, MS	RICE / WOODS CROSSING BLVD CAN	28089030101	1
214	-90.04423523	32.61856461	MARTIN LUTHER KING DR AND GEORGE, MADISON COUNTY, MS	MARTIN LUTHER KING DR / GEORGE CAN	28089030500	1
215	-90.13108826	32.42473221	RICE RD AND HWY 51, MADISON COUNTY, MS	RICE RD / HWY 51 CAN	28089030105	1
216	-90.10944366	32.57920837	HWY 22 AND LAKESHIRE PKWY, MADISON COUNTY, MS	HWY 22 / LAKESHIRE PKWY CAN	28089030400	1
217	-90.0565567	32.6100235	PEACE ST AND FULTON ST, MADISON COUNTY, MS	PEACE ST / FULTON ST CAN	28089030500	1
218	-89.84963989	32.59727859	NATCHEZ TRACE AND RATLIFF FERRY, MADISON COUNTY, MS	NATCHEZ TRACE / RATLIFF FERRY CAN	28089030900	1
219	-90.03639221	32.61136627	UNION ST AND W FULTON ST, MADISON COUNTY, MS	UNION ST / W FULTON ST CAN	28089030700	1
220	-90.03140259	32.62365723	DOBSON AVE AND SHERWOOD DR, MADISON COUNTY, MS	DOBSON AVE / SHERWOOD DR CAN	28089030600	1
221	-90.04206848	32.61503601	CANAL ST AND W NORTH ST, MADISON COUNTY, MS	CANAL ST / W NORTH ST CAN	28089030500	1
222	-89.83123016	32.67559052	LOTTVILLE RD AND JOHN DAY RD, MADISON COUNTY, MS	LOTTVILLE RD / JOHN DAY RD CAN	28089030900	1
223	-90.04634094	32.60636902	CAUTHEN ST AND ROSEBUD DR, MADISON COUNTY, MS	CAUTHEN ST / ROSEBUD DR CAN	28089030500	1
224	-90.03804016	32.53884125	N OLD CANTON RD AND COTTON BLOSSOM, MADISON COUNTY, MS	N OLD CANTON RD / COTTON BLOSSOM CAN	28089030400	1
225	-90.15769958	32.53746414	STRIBLING RD AND DEWEES, MADISON COUNTY, MS	STRIBLING RD / DEWEES CAN	28089030400	1
226	-90.04529572	32.60890961	W OTTO ST AND COWAN ST, MADISON COUNTY, MS	W OTTO ST / COWAN ST CAN	28089030500	1
227	-90.12355804	32.41132355	PEAR ORCHARD ROAD AND PEAR ORCHARD CIRCLE, MADISON COUNTY, MS	Pear Orchard Road/Pear Orchard Circle	28089030106	1
228	-89.76430511	32.68559647	HWY 16 EAST AND VIRGIN MARY RD, MADISON COUNTY, MS	HWY 16 EAST / VIRGIN MARY RD CAN	28089030900	1

APPENDIX D

COMPILED UNIQUE ROADBLOCKS:

Dr. Ricchetti's 1,697 CAD Roadblocks and 146 "Additional Roadblocks" from Incident Reports

	attributes_x	attributes_y	clean_address	original_address	geoid	number_of_roadblocks
229	-90.31272125	32.5387001	FIRST ST AND ODOM ST, MADISON COUNTY, MS	FIRST ST / ODOM ST CAN	28089030302	1
230	-89.90139008	32.61052704	RATLIFF FERRY RD AND LONE PINE R, MADISON COUNTY, MS	RATLIFF FERRY RD / LONE PINE R CAN	28089030900	1
231	-90.31288147	32.54216385	FIRST ST AND MAIN ST, MADISON COUNTY, MS	FIRST ST / MAIN ST FLO	28089030302	1
232	-90.02425385	32.6227417	GARFIELD ST AND LINCOLN ST, MADISON COUNTY, MS	GARFIELD ST / LINCOLN ST CAN	28089030600	1
233	-90.14138031	32.51689148	GLUCKSTADT RD AND C STORE, MADISON COUNTY, MS	GLUCKSTADT RD / C STORE CAN	28089030301	1
234	-90.13147736	32.39951324	EAST COUNTY LINE ROAD AND MOSSLINE DRIVE, MADISON COUNTY, MS	East County Line Road / Mossline Drive	28089030106	1
235	-90.00817871	32.61122131	HWY 16 AND HWY 43, MADISON COUNTY, MS	HWY 16 / HWY 43 CAN	28089030600	1
236	-90.06335449	32.46813965	OLD RICE RD AND ASPEN DR, MADISON COUNTY, MS	OLD RICE RD / ASPEN DR CAN	28089030201	1
237	-90.11382294	32.41400146	711 LAKE HARBOUR DR, MADISON COUNTY, MS	711 LAKE HARBOUR DR RID	28089030106	1
238	-90.10623932	32.53151703	STRIBLING EXT AND CHURCH, MADISON COUNTY, MS	STRIBLING EXT / CHURCH CAN	28089030400	1
239	-90.31713104	32.58966446	HUNT AVE AND LIVINGSTON VERNON R, MADISON COUNTY, MS	HUNT AVE / LIVINGSTON VERNON R FLO	28089030302	1
240	-89.96974945	32.61860275	E HWY 16 AND ROBINSON RD, MADISON COUNTY, MS	E HWY 16 / ROBINSON RD CAN	28089030900	1
241	-89.75099945	32.76061249	HWY 43 AND MATLOCK RD, MADISON COUNTY, MS	HWY 43 / MATLOCK RD CAN	28089031000	1
242	-89.81078339	32.64796829	ROBINSON RD AND PAT LUCKETT RD, MADISON COUNTY, MS	ROBINSON RD / PAT LUCKETT RD CAN	28089030900	1
243	-90.17900085	32.47502518	N LIVINGSTON RD AND MCDONALD DR, MADISON COUNTY, MS	N LIVINGSTON RD / MCDONALD DR CAN	28089030302	1
244	-90.10637665	32.41625214	OLD CANTON RD AND MRA, MADISON COUNTY, MS	OLD CANTON RD / MRA MAD	28089030104	1
245	-90.05216217	32.62361526	1101 HOLMES AV, MADISON COUNTY, MS	1101 HOLMES AV CAN	28089030500	1
246	-90.10262299	32.40516281	875 WILLIAM BLVD, MADISON COUNTY, MS	875 WILLIAM BLVD RID	28089030108	1
247	-90.20373535	32.40357208	N LIVINGSTON RD AND MARY MYLES RD, MADISON COUNTY, MS	N LIVINGSTON RD / MARY MYLES RD RID	28089030206	1
248	-90.10137939	32.51712036	N. I-55 AND GLUCKSTADT ROAD, MADISON COUNTY, MS	N. I-55/Gluckstadt Road	28089030400	1
249	-90.05374146	32.61559296	112 SUNSET AVE, MADISON COUNTY, MS	112 SUNSET AVE CAN	28089030500	1
250	-90.00685883	32.67412186	HWY 51 AND PISGAH BOTTOM RD, MADISON COUNTY, MS	HWY 51 / PISGAH BOTTOM RD CAN	28089030900	1
251	-90.12696075	32.5234375	STILLHOUSE CREEK DR, MADISON COUNTY, MS	STILLHOUSE CREEK DR CAN	28089030400	1
252	-90.29964447	32.53530502	POCAHONTAS RD AND JEFFREYS RD, MADISON COUNTY, MS	POCAHONTAS RD / JEFFREYS RD FLO	28089030302	1
253	-90.08908081	32.56077576	OLD JACKSON RD AND RAGSDALE RD, MADISON COUNTY, MS	OLD JACKSON RD / RAGSDALE RD MAD	28089030400	1
254	-89.90813446	32.65834427	OLD HWY 16 AND CHURCH LN, MADISON COUNTY, MS	OLD HWY 16 / CHURCH LN CAN	28089030900	1
255	-90.02883148	32.51694489	YANDELL RD AND DEERFIELD BLVD, MADISON COUNTY, MS	YANDELL RD / DEERFIELD BLVD CAN	28089030400	1
256	-89.81421661	32.65003967	HHY 43 AND HWY 17, MADISON COUNTY, MS	HHY 43 / HWY 17 CAN	28089030900	1
257	-90.14666748	32.40386963	HWY 51 AND I-55, MADISON COUNTY, MS	HWY 51 / I-55 RID	28089030105	1
258	-90.10635376	32.42143631	OLD CANTON RD AND RICE RD, MADISON COUNTY, MS	OLD CANTON RD / RICE RD RID	28089030107	1
259	-90.19897461	32.42369843	N LIVINGSTON RD AND ROUSER RD, MADISON COUNTY, MS	N LIVINGSTON RD / ROUSER RD RID	28089030205	1
260	-90.05458832	32.6402626	GREEN ACRES AND KING RANCH, MADISON COUNTY, MS	GREEN ACRES / KING RANCH CAN	28089030500	1
261	-89.73869324	32.69438934	E HWY 16 AND PERMENTER RD, MADISON COUNTY, MS	E HWY 16 / PERMENTER RD CAN	28089030900	1
262	-90.00299072	32.61637878	COVINGTON DR AND HWY 43, MADISON COUNTY, MS	COVINGTON DR / HWY 43 CAN	28089030600	1
263	-90.03262329	32.63559341	W HWY 16 AND OIL MILL QUARTERS RD, MADISON COUNTY, MS	W HWY 16 / OIL MILL QUARTERS RD CAN	28089030600	1
264	-90.34346008	32.52296066	W HWY 22, MADISON COUNTY, MS	W HWY 22 CAN	28089030302	1
265	-90.03488922	32.61512756	HWY 51 AND N MAD, MADISON COUNTY, MS	HWY 51 / N MAD CAN	28089030600	1
266	-90.04753113	32.61672592	349 WELCH ST, MADISON COUNTY, MS	349 WELCH ST CAN	28089030500	1

APPENDIX D

COMPILED UNIQUE ROADBLOCKS:

Dr. Ricchetti's 1,697 CAD Roadblocks and 146 "Additional Roadblocks" from Incident Reports

	attributes_x	attributes_y	clean_address	original_address	geoid	number_of_roadblocks
267	-90.18817139	32.51525497	HWY 463 AND REUNION BLVD, MADISON COUNTY, MS	HWY 463 / REUNION BLVD MAD	28089030301	1
268	-90.14444733	32.51688385	GLUCKSTADT RD AND KRISTEN HILL RD, MADISON COUNTY, MS	GLUCKSTADT RD / KRISTEN HILL RD CAN	28089030400	1
269	-90.05065155	32.61747742	390 RICKS DR, MADISON COUNTY, MS	390 RICKS DR CAN	28089030500	1
270	-89.93041992	32.78058243	LORING RD AND TUCKER RD, MADISON COUNTY, MS	LORING RD / TUCKER RD CAN	28089031000	1
271	-90.03502655	32.6380806	CMUANDRAILROAD, MADISON COUNTY, MS	CMU/RAILROAD CAN	28089030600	1
272	-90.16139984	32.4300766	OLD AGENCY RD AND DINSMOR CRSG, MADISON COUNTY, MS	OLD AGENCY RD / DINSMOR CRSG RID	28089030206	1
273	-90.08551025	32.51168823	HWY 51 AND YANDELL RD, MADISON COUNTY, MS	HWY 51 / YANDELL RD CAN	28089030400	1
274	-90.04384613	32.61013031	W ACADEMY ST AND S WALNUT ST, MADISON COUNTY, MS	W ACADEMY ST / S WALNUT ST CAN	28089030500	1
275	-90.30622101	32.5386734	POCAHONTAS RD AND WATSON ST, MADISON COUNTY, MS	POCAHONTAS RD / WATSON ST CAN	28089030302	1
276	-90.05490875	32.47240448	OLD RICE RD AND MADI, MADISON COUNTY, MS	OLD RICE RD / MADI CAN	28089030201	1
277	-90.01125336	32.74898529	WAY RD AND GRAY CENTER RD, MADISON COUNTY, MS	WAY RD / GRAY CENTER RD CAN	28089031000	1
278	-90.08907318	32.56425858	OLD JACKSON RD AND HILL RD, MADISON COUNTY, MS	OLD JACKSON RD / HILL RD CAN	28089030400	1
279	-90.04050446	32.60404968	TROLIO ST AND W DINKINS ST, MADISON COUNTY, MS	TROLIO ST / W DINKINS ST CAN	28089030700	1
280	-90.31697845	32.58352661	KEARNEY PARK RD AND MRS ST, MADISON COUNTY, MS	KEARNEY PARK RD / MRS ST CAN	28089030302	1
281	-90.21385956	32.46538544	LAKE CAVALIER ROAD AND SUNSET LANE, MADISON COUNTY, MS	Lake Cavalier Road / Sunset lane	28089030302	1
282	-90.04238892	32.60974121	S CANAL ST AND APPT COMPLEX, MADISON COUNTY, MS	S CANAL ST / APPT COMPLEX CAN	28089030500	1
283	-90.13632202	32.53750229	CATLETT RD AND STRIBLING RD, MADISON COUNTY, MS	CATLETT RD / STRIBLING RD CAN	28089030400	1
284	-90.26086426	32.49780273	ROBINSON SPRINGS RD AND ROBINSON, MADISON COUNTY, MS	ROBINSON SPRINGS RD / ROBINSON CAN	28089030302	1
285	-90.14391327	32.4360466	I-55 S AND RIDGELAND, MADISON COUNTY, MS	I-55 S / RIDGELAND CAN	28089030101	1
286	-90.04675293	32.61555862	BOYD ST, MADISON COUNTY, MS	Boyd St	28089030500	1
287	-90.0869751	32.41513824	BREAKERS LN, MADISON COUNTY, MS	BREAKERS LN CAN	28089030107	1
288	-90.04016113	32.49512863	TWELVE OAKS RD AND OLD CANTON RD, MADISON COUNTY, MS	TWELVE OAKS RD / OLD CANTON RD CAN	28089030201	1
289	-90.03968811	32.64033508	GREEN ACRES DR AND HWY 16W, MADISON COUNTY, MS	GREEN ACRES DR / HWY 16W CAN	28089030500	1
290	-90.13685608	32.54156876	TYLER LN AND CATLETT RD, MADISON COUNTY, MS	TYLER LN / CATLETT RD CAN	28089030400	1
291	-90.20355225	32.4080658	LIVINGSTON RD AND PEATRY PENDLETON, MADISON COUNTY, MS	LIVINGSTON RD / PEATRY PENDLETON RID	28089030206	1
292	-90.03132629	32.51693344	43 AND YANDELL RD, MADISON COUNTY, MS	43 / YANDELL RD CAN	28089030400	1
293	-90.05483246	32.6184845	KING RANCH RD AND GEORGE WASHINGTON AVE, MADISON COUNTY, MS	KING RANCH RD / GEORGE WASHINGTON AVE CAN	28089030500	1
294	-90.1555481	32.43022919	NATCHEZ TRACE AND GREENWOOD XING, MADISON COUNTY, MS	NATCHEZ TRACE / GREENWOOD XING RID	28089030206	1
295	-89.99462891	32.61118317	E HWY 16 AND COUNTRY CLUB DR, MADISON COUNTY, MS	E HWY 16 / COUNTRY CLUB DR CAN	28089030800	1
296	-89.93830109	32.7806282	LORING RD AND HARGON RD, MADISON COUNTY, MS	LORING RD / HARGON RD CAN	28089031000	1
297	-90.03336334	32.74444962	WAY RD AND WAY CIR, MADISON COUNTY, MS	WAY RD / WAY CIR CAN	28089031000	1
298	-90.10635376	32.43982315	RIDGECREST DR AND OLD CANTON RD, MADISON COUNTY, MS	RIDGECREST DR / OLD CANTON RD MAD	28089030101	1
299	-90.04935455	32.61853027	MACE STREET AND GEORGE WASHINGTON ST, MADISON COUNTY, MS	Mace Street / George Washington St	28089030500	1
300	-89.94203186	32.85522842	HWY 17 AND OLD 51 RD, MADISON COUNTY, MS	HWY 17 / OLD 51 RD PIC	28089031000	1
301	-90.11235046	32.4099884	NORTH PARK DR AND FONTAINE PL, MADISON COUNTY, MS	NORTH PARK DR / FONTAINE PL CAN	28089030106	1
302	-90.11093903	32.46031189	YANDELL AND MADISON CROSSING, MADISON COUNTY, MS	YANDELL / MADISON CROSSING CAN	28089030202	1
303	-90.14668274	32.53368759	SYCAMORE RIDGE AND ASHBROOKE BLV, MADISON COUNTY, MS	SYCAMORE RIDGE / ASHBROOKE BLV CAN	28089030400	1
304	-90.00198364	32.61001205	PEACE ST, MADISON COUNTY, MS	PEACE ST CAN	28089030600	1

APPENDIX D

COMPILED UNIQUE ROADBLOCKS:

Dr. Ricchetti's 1,697 CAD Roadblocks and 146 "Additional Roadblocks" from Incident Reports

	attributes_x	attributes_y	clean_address	original_address	geoid	number_of_roadblocks
305	-90.33811188	32.55318069	COX FERRY RD AND OLD HWY 49, MADISON COUNTY, MS	COX FERRY RD / OLD HWY 49 FLO	28089030302	1
306	-90.0328598	32.63660812	HWY 16 AND OIL MILL QUARTERS RD, MADISON COUNTY, MS	HWY 16 / OIL MILL QUARTERS RD CAN	28089030600	1
307	-90.31289673	32.54469299	FIRST ST AND CENTER ST, MADISON COUNTY, MS	FIRST ST / CENTER ST FLO	28089030302	1
308	-89.99717712	32.58401108	1528 HWY 43, MADISON COUNTY, MS	1528 HWY 43 CAN	28089030900	1
309	-90.04543304	32.6113739	ROBY ST AND W FULTON ST, MADISON COUNTY, MS	ROBY ST / W FULTON ST CAN	28089030500	1
310	-90.09463501	32.5136528	WEISENBERGER ROAD AND PARKWAY EAST, MADISON COUNTY, MS	Weisenberger Road / Parkway East	28089030204	1
311	-90.04283142	32.60404968	W DINKINS ST AND RANGE, MADISON COUNTY, MS	W DINKINS ST / RANGE CAN	28089030700	1
312	-90.05379486	32.62360382	HOLMES AVENUE AND WAYNE DRIVE, MADISON COUNTY, MS	Holmes Avenue/Wayne Drive	28089030500	1
313	-90.02436829	32.6204834	MILLER ST AND LINCOLN ST, MADISON COUNTY, MS	MILLER ST / LINCOLN ST CAN	28089030600	1
314	-89.79151154	32.75230408	HWY 43 AND HONEYSUCKER RD, MADISON COUNTY, MS	HWY 43 / HONEYSUCKER RD CAN	28089031000	1
315	-90.11849976	32.46476364	MADISON PARKWAY AND POST OAK RD, MADISON COUNTY, MS	MADISON PARKWAY / POST OAK RD MAD	28089030203	1
316	-90.09156799	32.49990845	1556 HWY 51, MADISON COUNTY, MS	1556 HWY 51 MAD	28089030201	1
317	-90.05487823	32.47242355	OLD RICE RD AND CHANNEL LN, MADISON COUNTY, MS	OLD RICE RD / CHANNEL LN MAD	28089030201	1
318	-90.31023407	32.54489517	111 KEARNEY PARK RD, MADISON COUNTY, MS	111 KEARNEY PARK RD FLO	28089030302	1
319	-90.0558548	32.472332	OLD RICE AND HALEY CREEK, MADISON COUNTY, MS	OLD RICE / HALEY CREEK CAN	28089030201	1
320	-90.04888916	32.62274933	1006 HOLMES AV, MADISON COUNTY, MS	1006 HOLMES AV CAN	28089030500	1
321	-89.98647308	32.61324692	HWY 16 AND GREENFIELD DR, MADISON COUNTY, MS	HWY 16 / GREENFIELD DR CAN	28089030900	1
322	-90.10093689	32.48181152	HWY 51 AND TISDALE RD, MADISON COUNTY, MS	HWY 51 / TISDALE RD MAD	28089030203	1
323	-90.08110046	32.56065369	NISSAN AND I-55, MADISON COUNTY, MS	NISSAN / I-55 CAN	28089030400	1
324	-90.03939056	32.60658646	CAMERON ST AND LEE ST, MADISON COUNTY, MS	CAMERON ST / LEE ST CAN	28089030700	1
325	-90.09635162	32.42125702	RICE RD AND HARBOR DR, MADISON COUNTY, MS	RICE RD / HARBOR DR CAN	28089030107	1
326	-90.05480194	32.62392807	KING RANCH AND PARKVIEW, MADISON COUNTY, MS	KING RANCH / PARKVIEW CAN	28089030500	1
327	-90.07202148	32.46506119	HOY RD AND N OLD CANTON RD, MADISON COUNTY, MS	HOY RD / N OLD CANTON RD CAN	28089030201	1
328	-90.06373596	32.55365753	HIGHWAY 51 AND SOUTH LIBERTY, MADISON COUNTY, MS	Highway 51 / South Liberty	28089030400	1
329	-89.83846283	32.78039551	HWY 17 AND MCCARTY RD, MADISON COUNTY, MS	HWY 17 / MCCARTY RD CAM	28089031000	1
330	-90.32426453	32.5896759	LIVINGSTON VERNON AND ST CHARLE, MADISON COUNTY, MS	LIVINGSTON VERNON / ST CHARLE CAN	28089030302	1
331	-90.31217194	32.55142593	KEARNEY PARK RD AND COURT ST, MADISON COUNTY, MS	KEARNEY PARK RD / COURT ST FLO	28089030302	1
332	-90.04385376	32.61133957	WALNUT ST AND W FULTON ST, MADISON COUNTY, MS	WALNUT ST / W FULTON ST CAN	28089030500	1
333	-89.87865448	32.6220932	ROBINSON RD AND PLEASANT GIFT RD, MADISON COUNTY, MS	ROBINSON RD / PLEASANT GIFT RD CAN	28089030900	1
334	-90.11325073	32.457798	HWY 51 AND MADISON AVE, MADISON COUNTY, MS	HWY 51 / MADISON AVE CAN	28089030203	1
335	-90.10720825	32.46508026	HOY RD AND OLD CANTON RD, MADISON COUNTY, MS	HOY RD / OLD CANTON RD CAN	28089030202	1
336	-89.9355011	32.64578247	1400 SHARON RD, MADISON COUNTY, MS	1400 SHARON RD CAN	28089030900	1
337	-90.17773438	32.53680038	103 N I-55, MADISON COUNTY, MS	103 N I-55 RID	28089030400	1
338	-90.32935333	32.58968353	LIVINGSTON VERNON RD AND EMMIT R, MADISON COUNTY, MS	LIVINGSTON VERNON RD / EMMIT R CAN	28089030302	1
339	-89.98319244	32.65552902	GOODLOE RD . HWY 43, MADISON COUNTY, MS	GOODLOE RD . HWY 43 CAN	28089030900	1
340	-89.93563843	32.65857315	HWY 43 AND GOO, MADISON COUNTY, MS	HWY 43 / GOO CAN	28089030900	1
341	-90.1352005	32.5415535	TYLER LN AND CAT, MADISON COUNTY, MS	TYLER LN / CAT CAN	28089030400	1
342	-90.04441833	32.58664703	2941 HWY 51, MADISON COUNTY, MS	2941 HWY 51 CAN	28089030400	1

APPENDIX D

COMPILED UNIQUE ROADBLOCKS:

Dr. Ricchetti's 1,697 CAD Roadblocks and 146 "Additional Roadblocks" from Incident Reports

	attributes_x	attributes_y	clean_address	original_address	geoid	number_of_roadblocks
343	-90.08921051	32.53160858	CHURCH RD AND OLD JACKSON RD, MADISON COUNTY, MS	CHURCH RD / OLD JACKSON RD CAN	28089030400	1
344	-90.01306152	32.51686478	YANDELL RD AND BAINBRIDGE CROSSI, MADISON COUNTY, MS	YANDELL RD / BAINBRIDGE CROSSI MAD	28089030900	1
345	-90.11871338	32.46292877	MAIN ST AND POST OAK RD, MADISON COUNTY, MS	MAIN ST / POST OAK RD CAN	28089030203	1
346	-90.09118652	32.52015686	N INDUSTRIAL BLVD, MADISON COUNTY, MS	N INDUSTRIAL BLVD CAN	28089030400	1
347	-90.10639954	32.42711639	OLD CANTON RD AND NATCHEZ TRACE, MADISON COUNTY, MS	OLD CANTON RD / NATCHEZ TRACE RID	28089030101	1
348	-90.31713867	32.58966446	KEARNEY PARK AND LIVINGSTON VERNON, MADISON COUNTY, MS	KEARNEY PARK / LIVINGSTON VERNON CAN	28089030302	1
349	-90.15924835	32.68291092	HWY 22 AND PANTHER CREEK, MADISON COUNTY, MS	HWY 22 / PANTHER CREEK CAN	28089030400	1
350	-90.08528137	32.68191147	WILLIAMS BLVD, MADISON COUNTY, MS	WILLIAMS BLVD CAN	28089030400	1
351	-90.22227478	32.49411392	ROBINSON SPRING RD AND COKER RD, MADISON COUNTY, MS	ROBINSON SPRING RD / COKER RD CAN	28089030302	1
352	-90.10136414	32.40216827	PINE KNOLL CT, MADISON COUNTY, MS	PINE KNOLL CT RID	28089030108	1
353	-90.01058197	32.61730576	COVINGTON DRIVE AND CISNE AVE, MADISON COUNTY, MS	Covington Drive / Cisne Ave	28089030600	1
354	-90.04670715	32.6129837	108 BOYD STREET, MADISON COUNTY, MS	108 Boyd Street	28089030500	1
355	-89.96806335	32.64184952	HWY 43 AND QUAIL RD, MADISON COUNTY, MS	HWY 43 / QUAIL RD CAN	28089030900	1
356	-90.0927887	32.49762344	HWY 51 AND GROSS RD, MADISON COUNTY, MS	HWY 51 / GROSS RD MAD	28089030204	1
357	-90.30010223	32.56463623	HARRIS RD AND HARRIS SUBDIVISION, MADISON COUNTY, MS	HARRIS RD / HARRIS SUBDIVISION FLO	28089030302	1
358	-90.07840729	32.60264587	HWY 22 AND VIRLILIA RD, MADISON COUNTY, MS	HWY 22 / VIRLILIA RD CAN	28089030400	1
359	-90.17762756	32.42744827	OLD AGENCY RD AND PATTERSON, MADISON COUNTY, MS	OLD AGENCY RD / PATTERSON CAN	28089030205	1
360	-89.93049622	32.65864182	OLD HWY 16 AND ROBERT DEARON RD, MADISON COUNTY, MS	OLD HWY 16 / ROBERT DEARON RD CAN	28089030900	1
361	-90.03488159	32.61856461	UNION ST AND LIBERTY ST, MADISON COUNTY, MS	UNION ST / LIBERTY ST CAN	28089030600	1
					TOTAL	1843

APPENDIX D

Roadblocks Straddling Census Tract Boundaries

FID	attributes	attribut_1	clean_addr	original_a	geoid	number_of_roadblocks	Point_numb
0	-90.17705536	32.4002533	W COUNTY LINE RD AND I-220, MADISON COUNTY, MS	W COUNTY LINE RD / I-220 RID	28089030206	114	1
1	-90.08860779	32.41168594	LOWER SPILLWAY RD, MADISON COUNTY, MS	LOWER SPILLWAY RD RID	28089030107	65	3
2	-90.10803986	32.40254593	OLD CANTON RD AND PINE KNOLL DR, MADISON COUNTY, MS	OLD CANTON RD / PINE KNOLL DR RID	28089030106	59	4
3	-90.03372955	32.64034653	W HWY 16 AND GREEN ACRES, MADISON COUNTY, MS	W HWY 16 / GREEN ACRES CAN	28089030600	38	8
4	-90.03488159	32.64033508	GREEN ACRES AND RAILROAD ST, MADISON COUNTY, MS	GREEN ACRES / RAILROAD ST CAN	28089030500	32	11
5	-89.9750061	32.52461243	HWY 43 AND NATCHEZ TRACE PKWY, MADISON COUNTY, MS	HWY 43 / NATCHEZ TRACE PKWY CAN	28089030201	25	14
6	-90.17292786	32.45587158	LAKE CASTLE RD AND RICHARDSON RD, MADISON COUNTY, MS	LAKE CASTLE RD / RICHARDSON RD CAN	28089030204	21	17
7	-90.09313965	32.41199875	HARBOR AND LAKE HARBOR, MADISON COUNTY, MS	HARBOR / LAKE HARBOR CAN	28089030107	20	18
8	-89.98714447	32.61305618	HWY 16 AND AVONDALE RD, MADISON COUNTY, MS	HWY 16 / AVONDALE RD CAN	28089030600	19	19
9	-90.10651398	32.40514755	OLD CANTON RD AND WILLIAM BLVD, MADISON COUNTY, MS	OLD CANTON RD / WILLIAM BLVD RID	28089030106	19	20
10	-90.10634613	32.41098785	HARBOUR PT XING AND OLD CANTON, MADISON COUNTY, MS	HARBOUR PT XING / OLD CANTON RID	28089030106	18	22
11	-90.13207245	32.4068222	TOWNE CENTER AND WHEATLEY, MADISON COUNTY, MS	TOWNE CENTER / WHEATLEY RID	28089030106	17	25
12	-90.19194031	32.52423477	HWY 463 AND GLUCKSTADT RD, MADISON COUNTY, MS	HWY 463 / GLUCKSTADT RD MAD	28089030301	12	33
13	-90.19989014	32.42080688	LIVINGSTON RD AND OLD AGENCY RD, MADISON COUNTY, MS	LIVINGSTON RD / OLD AGENCY RD CAN	28089030206	11	37
14	-90.17658997	32.40026093	I-220 AND W COUNTY LINE RD, MADISON COUNTY, MS	I-220 / W COUNTY LINE RD CAN	28089030206	11	39
15	-90.18656921	32.45495224	N LIVINGSTON RD AND LAKE CASTLE RD, MADISON COUNTY, MS	N LIVINGSTON RD / LAKE CASTLE RD MAD	28089030302	10	43
16	-89.97753906	32.52706146	HWY 43 AND YANDELL RD, MADISON COUNTY, MS	HWY 43 / YANDELL RD CAN	28089030201	9	49
17	-90.24606323	32.56061554	LIVINGSTON VERNON RD AND STOKES, MADISON COUNTY, MS	LIVINGSTON VERNON RD / STOKES CAN	28089030302	8	50
18	-89.99343109	32.51694489	YANDELL RD AND TWELVE OAKS TRACE, MADISON COUNTY, MS	YANDELL RD / TWELVE OAKS TRACE CAN	28089030201	8	51
19	-90.0888443	32.4116745	SPILLWAY RD AND BREAKERS LN, MADISON COUNTY, MS	SPILLWAY RD / BREAKERS LN RID	28089030108	8	53
20	-90.14375305	32.42818069	NATCHEZ TRACE PKWY AND I-55, MADISON COUNTY, MS	NATCHEZ TRACE PKWY / I-55 RID	28089030105	7	59
21	-90.20085907	32.44431686	LAKE CAVALIER RD AND N LIVINGSTO, MADISON COUNTY, MS	LAKE CAVALIER RD / N LIVINGSTO MAD	28089030302	7	64
22	-90.1235199	32.42500305	RICE RD AND PEAR ORCHARD RD, MADISON COUNTY, MS	RICE RD / PEAR ORCHARD RD RID	28089030104	6	67
23	-90.03852844	32.62369537	MARTIN LUTHER KING DR AND RAILRO, MADISON COUNTY, MS	MARTIN LUTHER KING DR / RAILRO CAN	28089030500	6	73
24	-90.10901642	32.41405106	LAKE HARBOUR DRIVE AND RANKIN, MADISON COUNTY, MS	Lake Harbour Drive / Rankin	28089030104	5	77
25	-90.15769196	32.51791	GLUCKSTADT RD AND DEWEES RD, MADISON COUNTY, MS	GLUCKSTADT RD / DEWEES RD CAN	28089030301	5	80
26	-89.8094635	32.7156105	HWY 17 AND SULPHUR SPRINGS RD, MADISON COUNTY, MS	HWY 17 / SULPHUR SPRINGS RD CAN	28089031000	5	85
27	-90.13199615	32.51691818	GLUCKSTADT RD AND CATLETT RD, MADISON COUNTY, MS	GLUCKSTADT RD / CATLETT RD CAN	28089030400	4	89
28	-90.07178497	32.51709747	YANDELL RD AND CLARKDELL RD, MADISON COUNTY, MS	YANDELL RD / CLARKDELL RD CAN	28089030400	4	98
29	-90.07054138	32.51710892	YANDELL RD AND MADISON CROSSING, MADISON COUNTY, MS	YANDELL RD / MADISON CROSSING MAD	28089030400	4	100
30	-90.18199921	32.40019989	W COUNTY LINE AND HIGHLAND COLONY, MADISON COUNTY, MS	W COUNTY LINE / HIGHLAND COLONY CAN	28089030206	4	101
31	-89.76596069	32.74020004	SULPHUR SPRING RD AND GIN RD, MADISON COUNTY, MS	SULPHUR SPRING RD / GIN RD CAN	28089030900	4	107
32	-90.09546661	32.49241257	HWY 51 AND GREEN OAK LN, MADISON COUNTY, MS	HWY 51 / GREEN OAK LN CAN	28089030204	4	108
33	-90.10624695	32.41098785	HARBOUR POINTE CROSSING AND NORT, MADISON COUNTY, MS	HARBOUR POINTE CROSSING / NORT RID	28089030108	4	110
34	-90.09117126	32.46505356	HOY RD AND RICE RD, MADISON COUNTY, MS	HOY RD / RICE RD MAD	28089030202	3	113
35	-90.01182556	32.63319778	FINNEY RD AND MORGAN RD, MADISON COUNTY, MS	FINNEY RD / MORGAN RD CAN	28089030600	3	115
36	-90.200737	32.4839325	ROBINSON SPRINGS RD AND POC, MADISON COUNTY, MS	ROBINSON SPRINGS RD / POC CAN	28089030302	3	118
37	-90.10951996	32.46508789	HWY 463 AND MADISON MIDDLE, MADISON COUNTY, MS	HWY 463 / MADISON MIDDLE CAN	28089030203	3	122
38	-89.96963501	32.52200317	HWY 43 AND TURCOTTE LAB DR, MADISON COUNTY, MS	HWY 43 / TURCOTTE LAB DR CAN	28089030900	3	124
39	-90.07056427	32.51711655	300 YANDELL RD, MADISON COUNTY, MS	300 YANDELL RD CAN	28089030400	3	127
40	-90.20282745	32.40014267	N LIVINGSTON RD AND COUNTY LINE, MADISON COUNTY, MS	N LIVINGSTON RD / COUNTY LINE CAN	28089030206	2	139
41	-90.12995911	32.42630768	HWY 51 AND NATCHEZ TRACE, MADISON COUNTY, MS	HWY 51 / NATCHEZ TRACE RID	28089030101	2	141
42	-90.072052	32.51708221	YANDELL RD AND BRACEY RD, MADISON COUNTY, MS	YANDELL RD / BRACEY RD CAN	28089030400	2	151
43	-90.19945526	32.42228317	N LIVINGSTON RD AND NATCHEZ TRACE BRIDGE, MADISON COUNTY, MS	N LIVINGSTON RD / NATCHEZ TRACE BRIDGE MAD	28089030206	2	154
44	-89.96032715	32.62166977	E HWY 16 AND ROYAL OAK RD, MADISON COUNTY, MS	E HWY 16 / ROYAL OAK RD CAN	28089030600	2	157

APPENDIX E

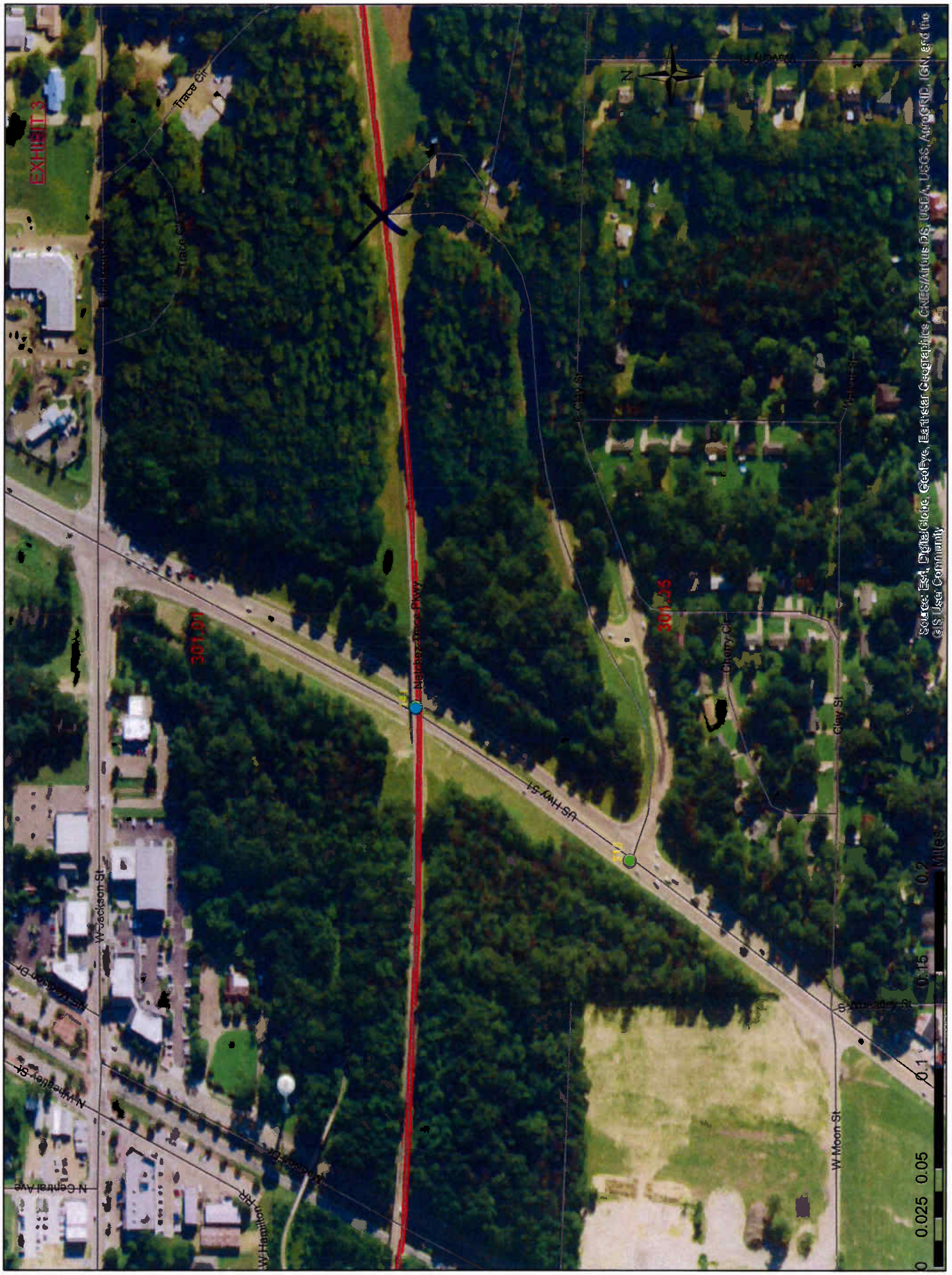
Roadblocks Straddling Census Tract Boundaries

45	-90.029953	32.61016083	ACADEMY ST AND LYON ST, MADISON COUNTY, MS	ACADEMY ST / LYON ST CAN	28089030800	2	158
46	-90.07616425	32.51581192	YANDELL RD AND CLARKDELL RD EXT, MADISON COUNTY, MS	YANDELL RD / CLARKDELL RD EXT CAN	28089030400	2	161
47	-90.03491211	32.60403824	S LIBERTY ST AND W DINKINS ST, MADISON COUNTY, MS	S LIBERTY ST / W DINKINS ST CAN	28089030700	2	166
48	-90.13915253	32.49761581	BOZEMAN RD AND REUNION ANNANDALE, MADISON COUNTY, MS	BOZEMAN RD / REUNION ANNANDALE CAN	28089030301	2	177
49	-90.10643768	32.45043564	OLD CANTON RD AND ST AUGUSTINE D, MADISON COUNTY, MS	OLD CANTON RD / ST AUGUSTINE D MAD	28089030101	1	188
50	-90.19879913	32.43163681	N LIVINGSTON RD AND COU, MADISON COUNTY, MS	N LIVINGSTON RD / COU CAN	28089030302	1	189
51	-90.11701202	32.45050812	HWY 51 AND ST AUGUSTINE DR, MADISON COUNTY, MS	HWY 51 / ST AUGUSTINE DR MAD	28089030101	1	194
52	-90.16146851	32.51902771	463 AND GLUCKSTADT RD, MADISON COUNTY, MS	463 / GLUCKSTADT RD CAN	28089030301	1	196
53	-89.97251129	32.52275848	HWY 43 AND BROWNS LANDING RD, MADISON COUNTY, MS	HWY 43 / BROWNS LANDING RD CAN	28089030201	1	203
54	-90.05475616	32.63266754	HEINDL RD AND KING RANCH RD, MADISON COUNTY, MS	HEINDL RD / KING RANCH RD CAN	28089030500	1	211
55	-90.14138031	32.51689148	GLUCKSTADT RD AND C STORE, MADISON COUNTY, MS	GLUCKSTADT RD / C STORE CAN	28089030301	1	233
56	-90.13147736	32.39951324	EAST COUNTY LINE ROAD AND MOSSLINE DRIVE, MADISON COUNTY, MS	East County Line Road / Mossline Drive	28089030106	1	234
57	-90.00817871	32.61122131	HWY 16 AND HWY 43, MADISON COUNTY, MS	HWY 16 / HWY 43 CAN	28089030600	1	235
58	-90.11382294	32.41400146	711 LAKE HARBOUR DR, MADISON COUNTY, MS	711 LAKE HARBOUR DR RID	28089030106	1	237
59	-89.96974945	32.61860275	E HWY 16 AND ROBINSON RD, MADISON COUNTY, MS	E HWY 16 / ROBINSON RD CAN	28089030900	1	240
60	-90.17900085	32.47502518	N LIVINGSTON RD AND MCDONALD DR, MADISON COUNTY, MS	N LIVINGSTON RD / MCDONALD DR CAN	28089030302	1	243
61	-90.10637665	32.41625214	OLD CANTON RD AND MRA, MADISON COUNTY, MS	OLD CANTON RD / MRA MAD	28089030104	1	244
62	-90.10262299	32.40516281	875 WILLIAM BLVD, MADISON COUNTY, MS	875 WILLIAM BLVD RID	28089030108	1	246
63	-90.10137939	32.51712036	N. I-55 AND GLUCKSTADT ROAD, MADISON COUNTY, MS	N. I-55/Gluckstadt Road	28089030400	1	248
64	-90.02883148	32.51694489	YANDELL RD AND DEERFIELD BLVD, MADISON COUNTY, MS	YANDELL RD / DEERFIELD BLVD CAN	28089030400	1	255
65	-90.10635376	32.42143631	OLD CANTON RD AND RICE RD, MADISON COUNTY, MS	OLD CANTON RD / RICE RD RID	28089030107	1	258
66	-90.19897461	32.42369843	N LIVINGSTON RD AND ROUSER RD, MADISON COUNTY, MS	N LIVINGSTON RD / ROUSER RD RID	28089030205	1	259
67	-90.05458832	32.6402626	GREEN ACRES AND KING RANCH, MADISON COUNTY, MS	GREEN ACRES / KING RANCH CAN	28089030500	1	260
68	-90.14444733	32.51688385	GLUCKSTADT RD AND KRISTEN HILL RD, MADISON COUNTY, MS	GLUCKSTADT RD / KRISTEN HILL RD CAN	28089030400	1	268
69	-90.08551025	32.51168823	HWY 51 AND YANDELL RD, MADISON COUNTY, MS	HWY 51 / YANDELL RD CAN	28089030400	1	273
70	-90.14391327	32.4360466	I-55 S AND RIDGELAND, MADISON COUNTY, MS	I-55 S / RIDGELAND CAN	28089030101	1	285
71	-90.03968811	32.64033508	GREEN ACRES DR AND HWY 16W, MADISON COUNTY, MS	GREEN ACRES DR / HWY 16W CAN	28089030500	1	289
72	-90.03132629	32.51693344	43 AND YANDELL RD, MADISON COUNTY, MS	43 / YANDELL RD CAN	28089030400	1	292
73	-90.00198364	32.61001205	PEACE ST, MADISON COUNTY, MS	PEACE ST CAN	28089030600	1	304
74	-90.09156799	32.49990845	1556 HWY 51, MADISON COUNTY, MS	1556 HWY 51 MAD	28089030201	1	316
75	-89.98647308	32.61324692	HWY 16 AND GREENFIELD DR, MADISON COUNTY, MS	HWY 16 / GREENFIELD DR CAN	28089030900	1	321
76	-90.10093689	32.48181152	HWY 51 AND TISDALE RD, MADISON COUNTY, MS	HWY 51 / TISDALE RD MAD	28089030203	1	322
77	-90.11325073	32.457798	HWY 51 AND MADISON AVE, MADISON COUNTY, MS	HWY 51 / MADISON AVE CAN	28089030203	1	334
78	-90.01306152	32.51686478	YANDELL RD AND BAINBRIDGE CROSSI, MADISON COUNTY, MS	YANDELL RD / BAINBRIDGE CROSSI MAD	28089030900	1	344
79	-90.10639954	32.42711639	OLD CANTON RD AND NATCHEZ TRACE, MADISON COUNTY, MS	OLD CANTON RD / NATCHEZ TRACE RID	28089030101	1	347
80	-90.0927887	32.49762344	HWY 51 AND GROSS RD, MADISON COUNTY, MS	HWY 51 / GROSS RD MAD	28089030204	1	356
81	-90.17762756	32.42744827	OLD AGENCY RD AND PATTERSON, MADISON COUNTY, MS	OLD AGENCY RD / PATTERSON CAN	28089030205	1	359

APPENDIX E


EXHIBIT 1
Red Bolt Rd
Levee Rd
Spillway Rd
Broadway Dr
Lakeview Dr
Shady Glen Rd
Harbor Pines Dr
Pine Ridge Dr
Dyke Rd
Ramp Rd
W Ramp Rd
W Ramp Rd
W Ramp Rd
Harbor Dr
Lake Harbour Dr
Candlewyck Dr
Copper Ridge
Copper Cove
Copper Cove
Ellis Cove
Craigs Cir
Bayside Cove
Lakeland Cove
Lakeshore Dr
Shore Dr
Beaverland Dr
301.07
301.08
Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
0 0.0425 0.085 0.17 0.255 0.34
Miles


EXHIBIT 2
301.07
301.08
Levee Rd
Spillway Rd
Breakers Ln
W Ramp Rd
Lake Harbour Dr
Harbor Pines Dr
Forest Grove Dr
Lakeview Cove
Pinetrail Dr
Shadow Lake Dr
O B Curtis Dr
0 0.0425 0.085 0.17 0.255 0.34
Miles
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community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US Hwy 51
W Jackson St
Natchez Trace Pkwy
Trace Cir
Clay St
Cherry Ct
W Moon St
N Wheatley St
N Central Ave
W Hamilton
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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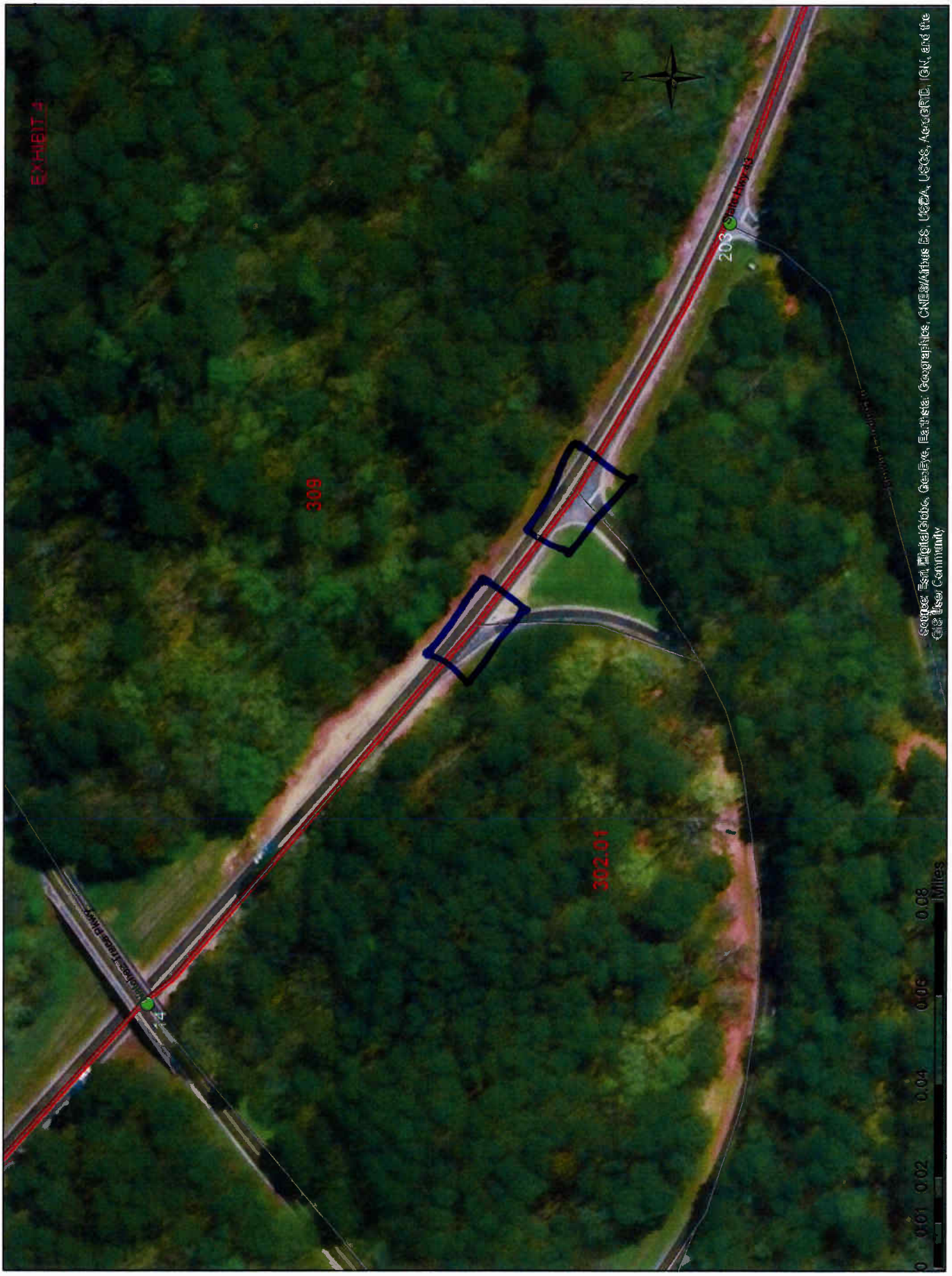
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203
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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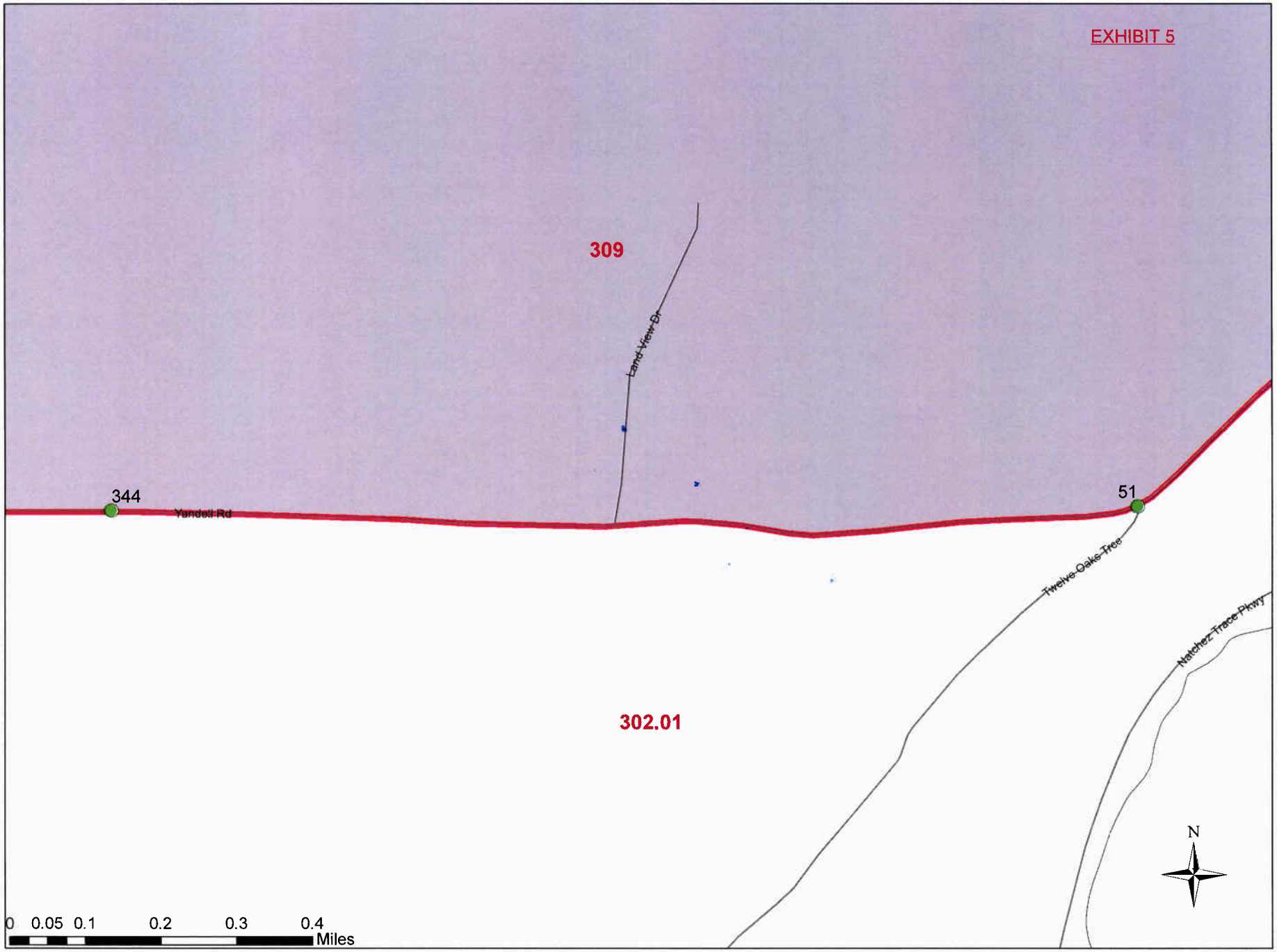
Miles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309
Land View Dr
344
Yandell Rd
51
Twelve Oaks Tree
Natchez Trace Pkwy
302.01
N
0 0.05 0.1 0.2 0.3 0.4
Miles


EXHIBIT 6
302.01
304
100
98
151
161
193
N
Bear Creek Cir
0 0.0325 0.065 0.13 0.195 0.26
Miles
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

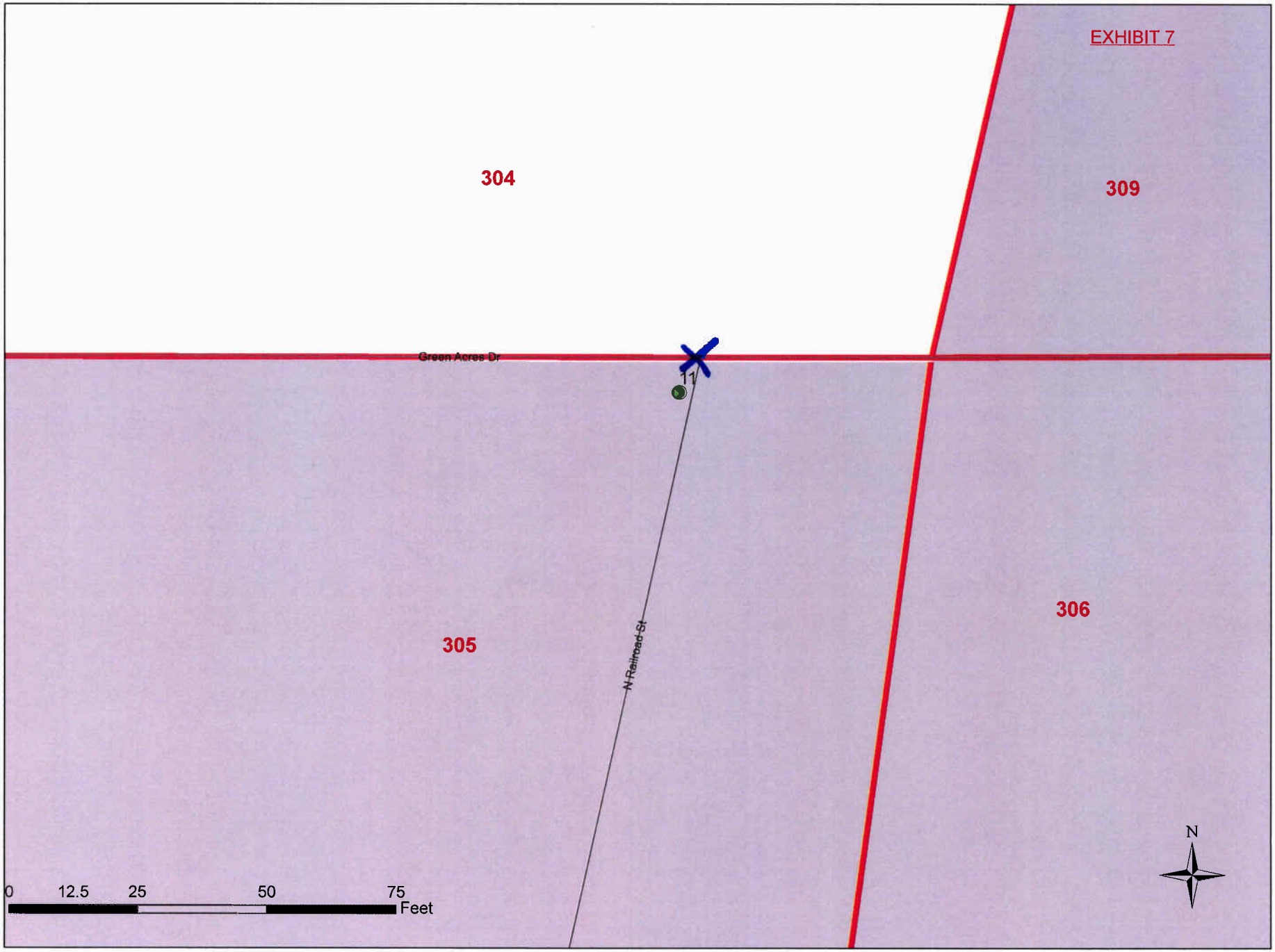
EXHIBIT 7
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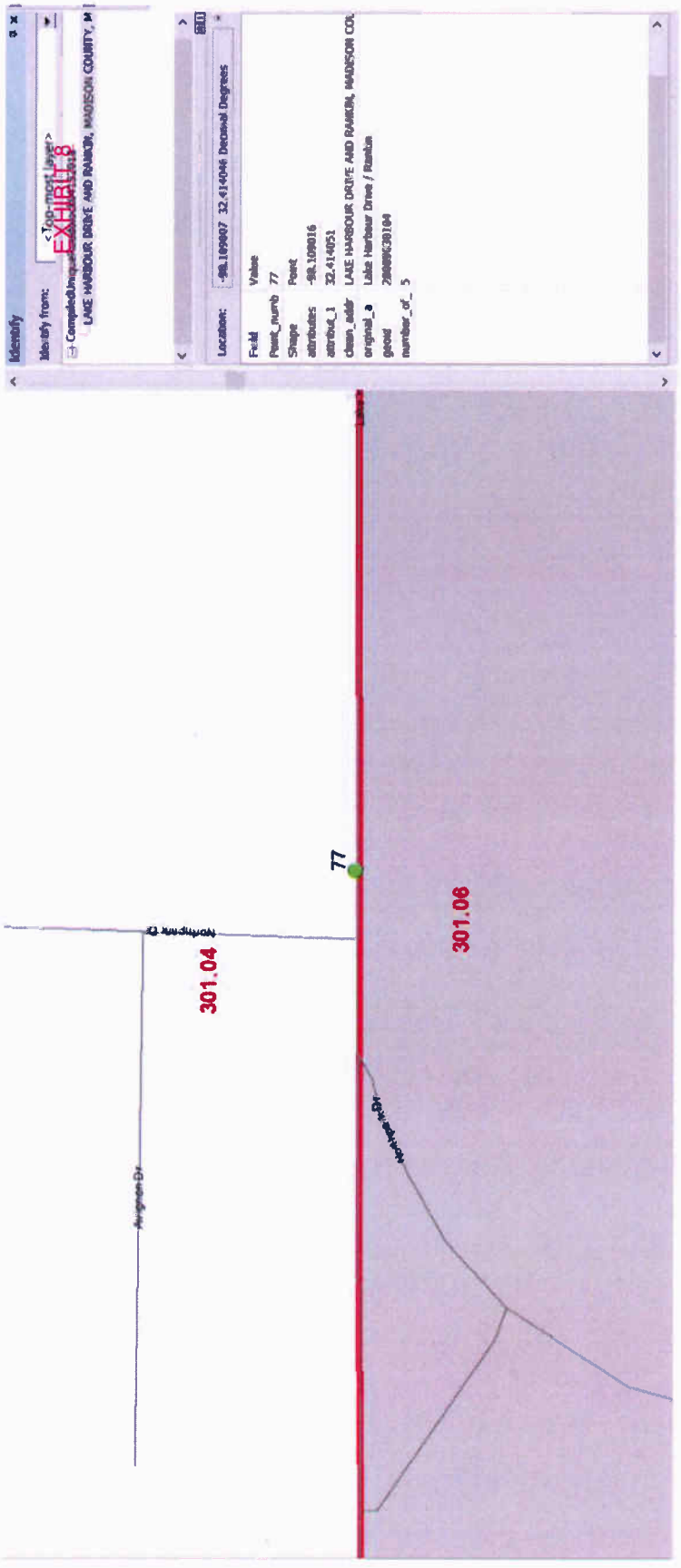
309
Green Acres Dr
11
305
N Railroad St
306
N
0
12.5
25
50
75
Feet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Shape
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LAKE HARBOUR DRIVE AND RAMON, MADISON CO
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Lake Harbour Drive / Ramon
geoid
28089039104
number_of_
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77
301.04
301.06
Arlington Dr
Lake Harbour Dr

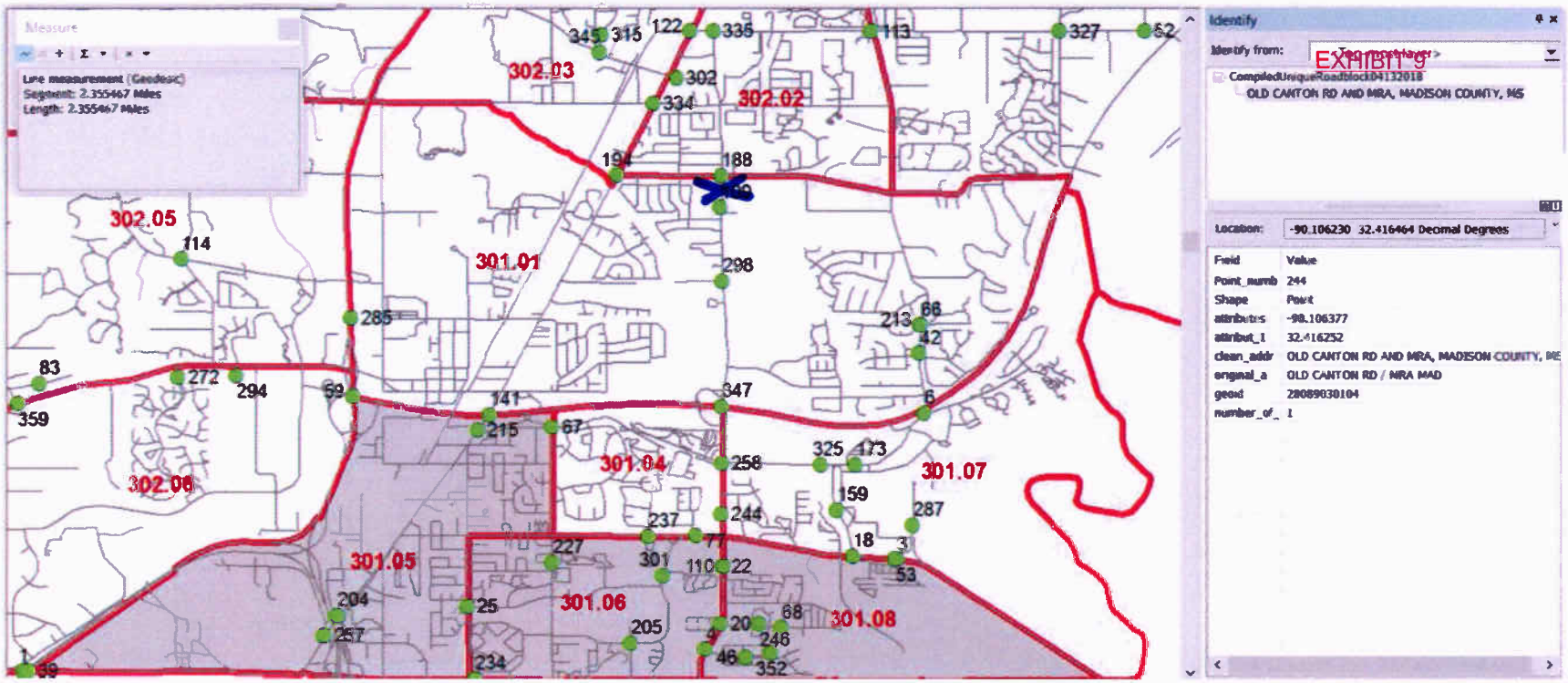

Measure
Line measurement (Geodesic)
Segment: 2.355467 Miles
Length: 2.355467 Miles
302.03
302.02
301.01
302.05
302.06
301.04
301.05
301.06
301.07
301.08
Identify
Identify from:
CompiledUniqueRoadblock04132018
OLD CANTON RD AND MRA, MADISON COUNTY, MS
Location: -90.106230 32.416464 Decimal Degrees
Field Value
Point_numb 244
Shape Point
attributes -90.106377
attribut_1 32.416252
clean_addr OLD CANTON RD AND MRA, MADISON COUNTY, MS
original_a OLD CANTON RD / MRA MAD
geoid 28089030104
number_of_ 1

EXHIBIT 9

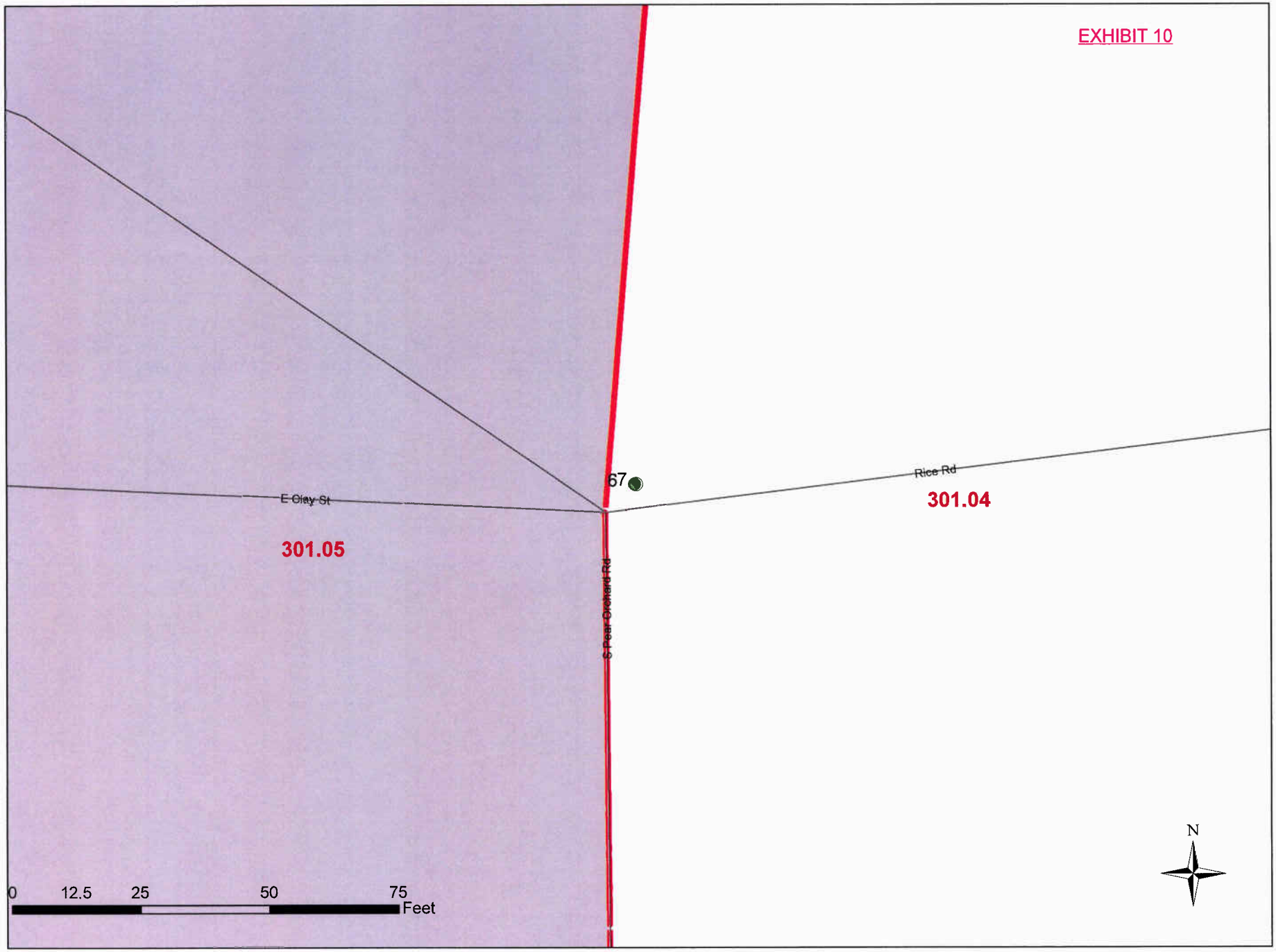


EXHIBIT 10
67
E Clay St
301.05
Rice Rd
301.04
S Pear Orchard Rd
N
0
12.5
25
50
75
Feet

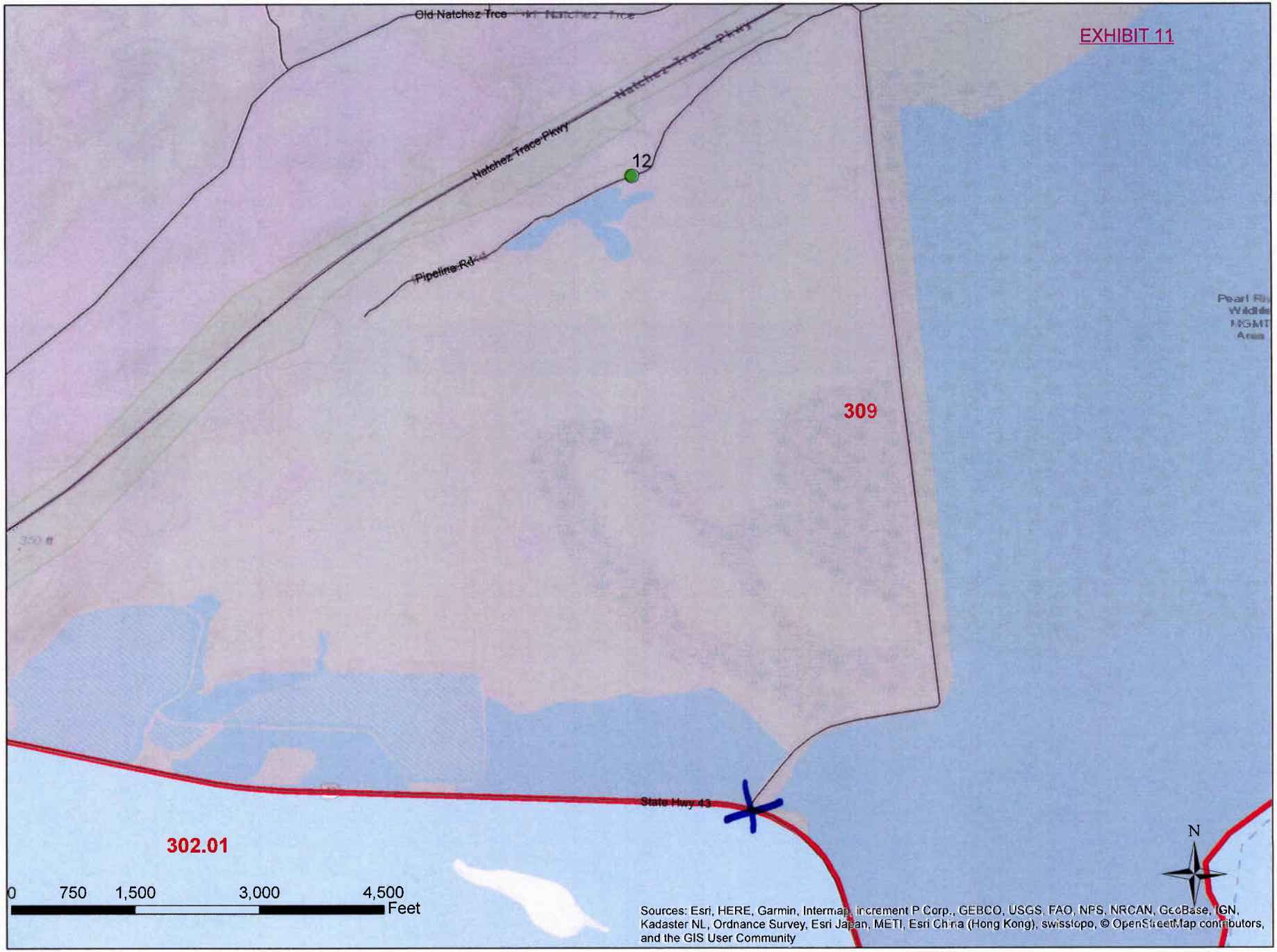


EXHIBIT 11
Old Natchez Trce
Natchez Trace Pkwy
Natchez Trace Pkwy
12
Pipeline Rd
309
302.01
State Hwy 43
0 750 1,500 3,000 4,500
Feet
N
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

EXHIBIT 12

Madison County 2010Census Blocks and "Predominantly" Black Census Tracts

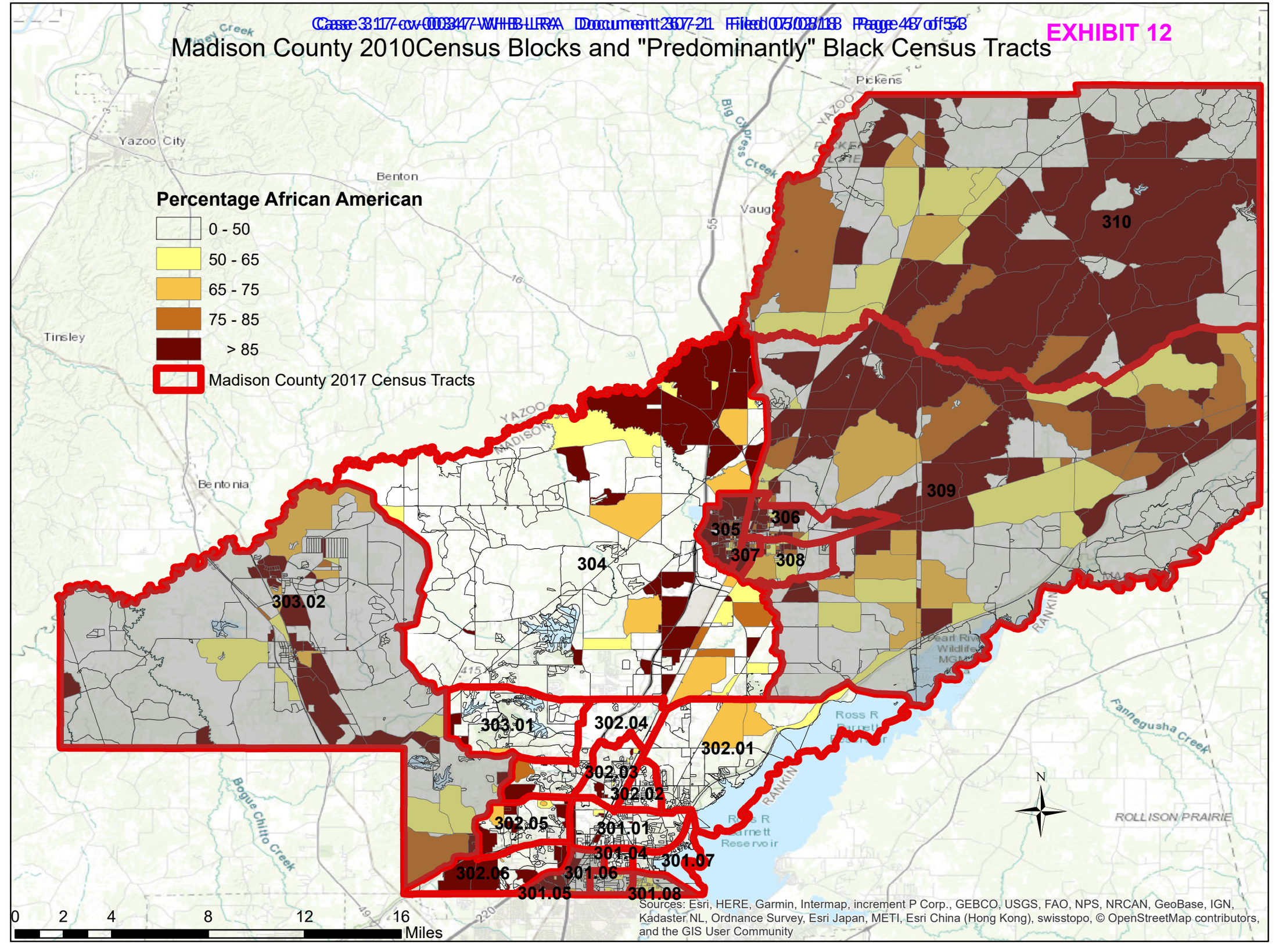
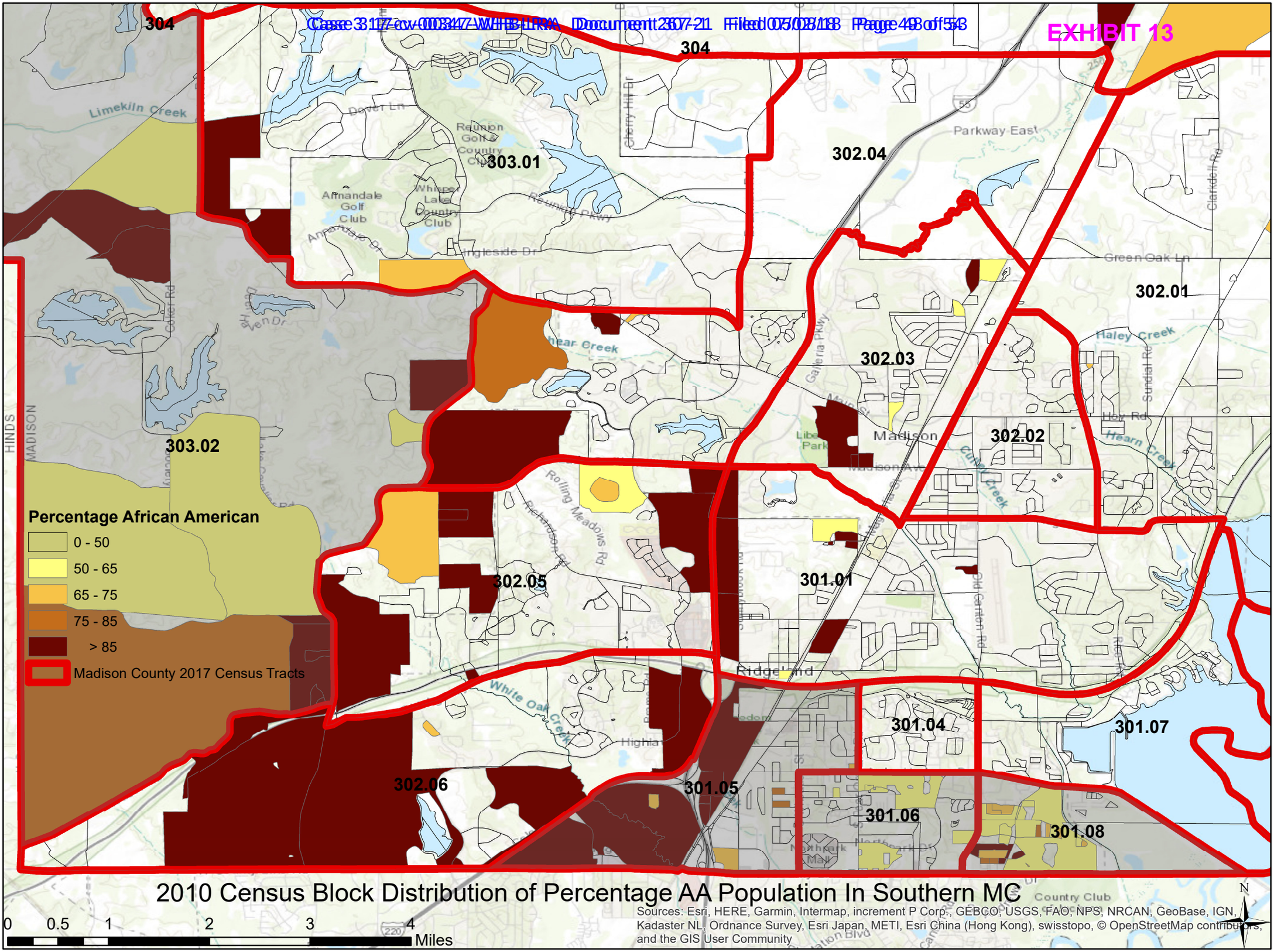


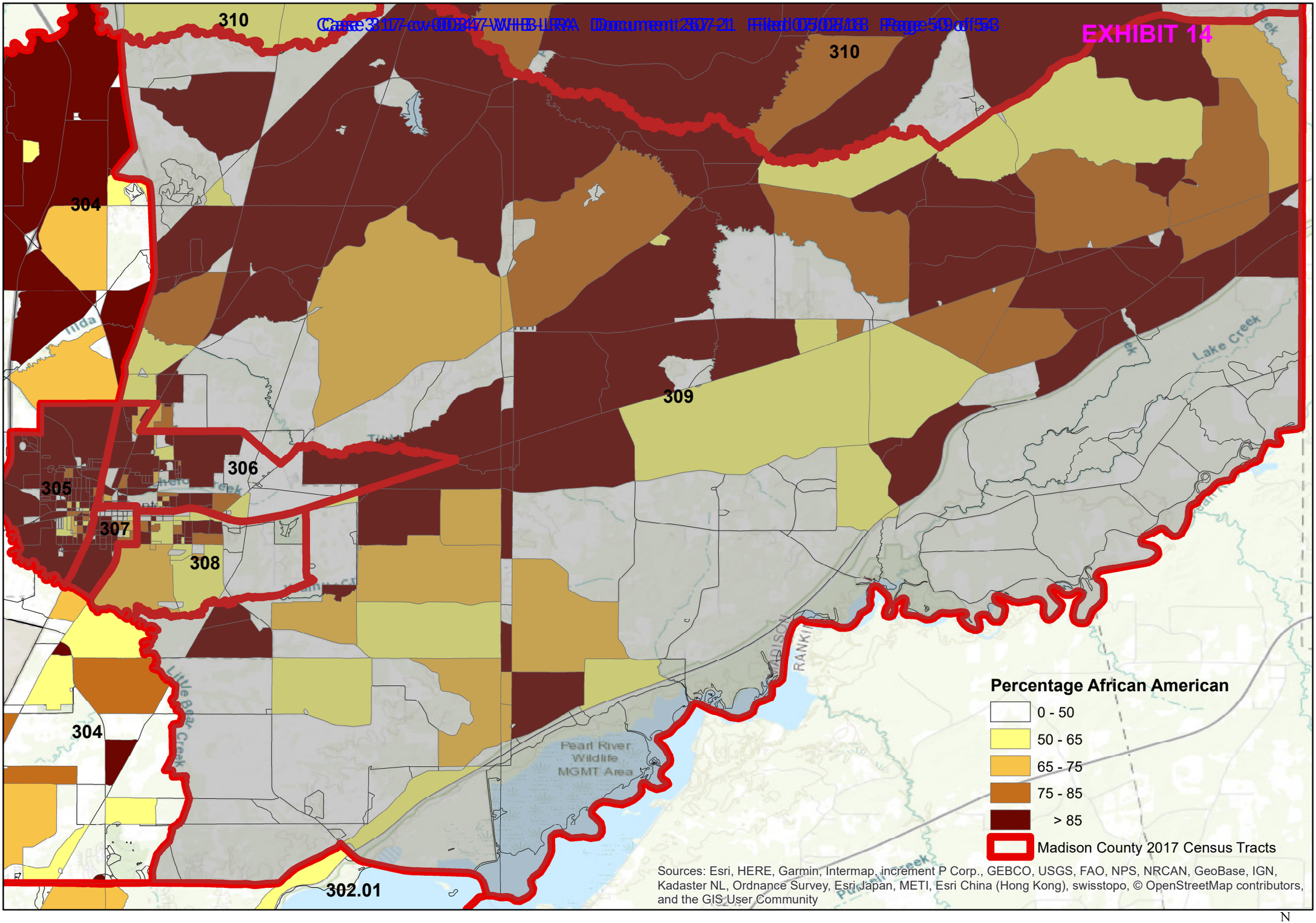
EXHIBIT 13



2010 Census Block Distribution of Percentage AA Population In Southern MC

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

EXHIBIT 14



2010 Census Block Distribution of Percentage African American Population In Tract 309

0 0.75 1.5 3 4.5 6
Miles

N

Distribution of Roadblocks Straddling Census Tract Boundaries

EXHIBIT 15

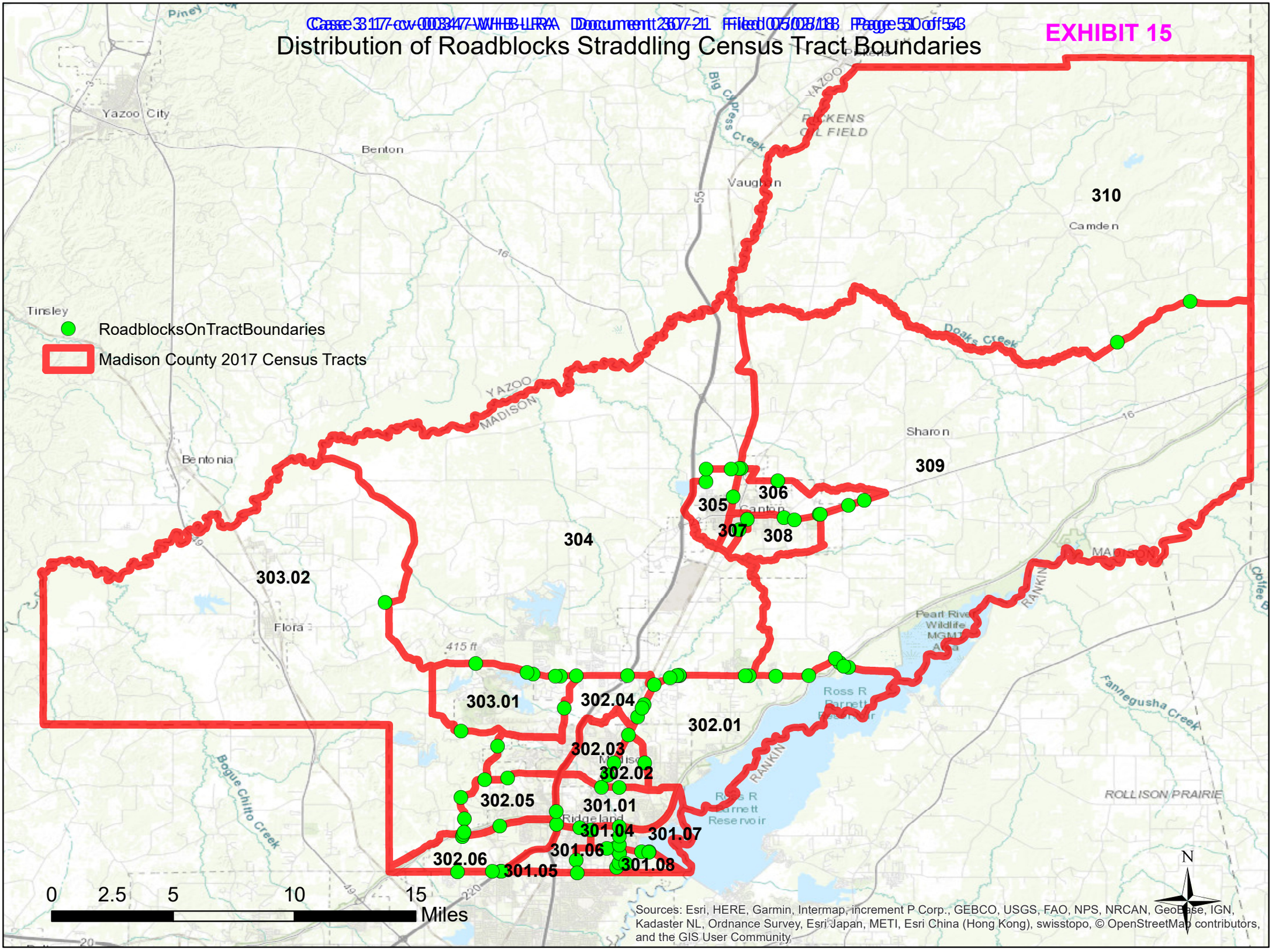
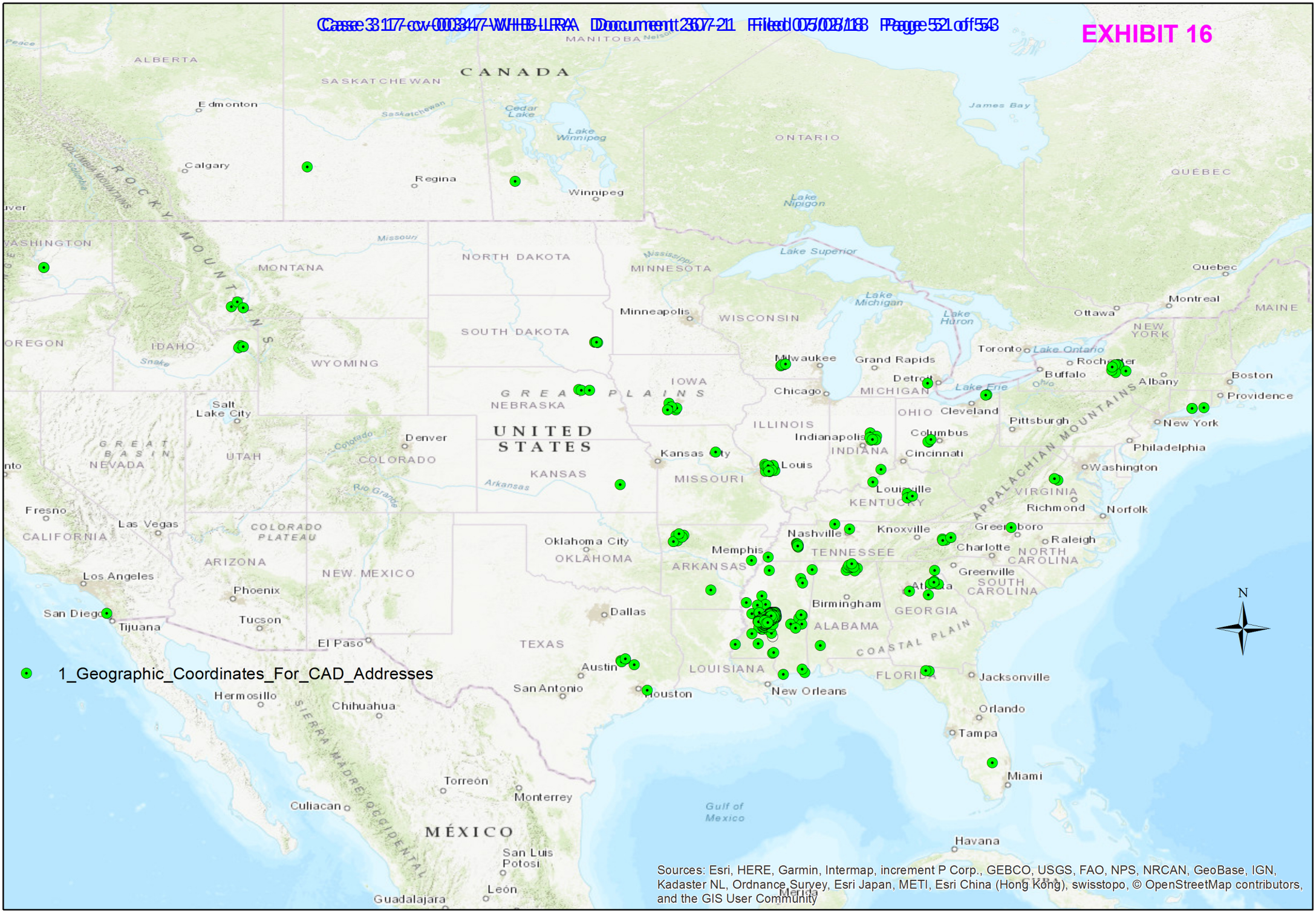


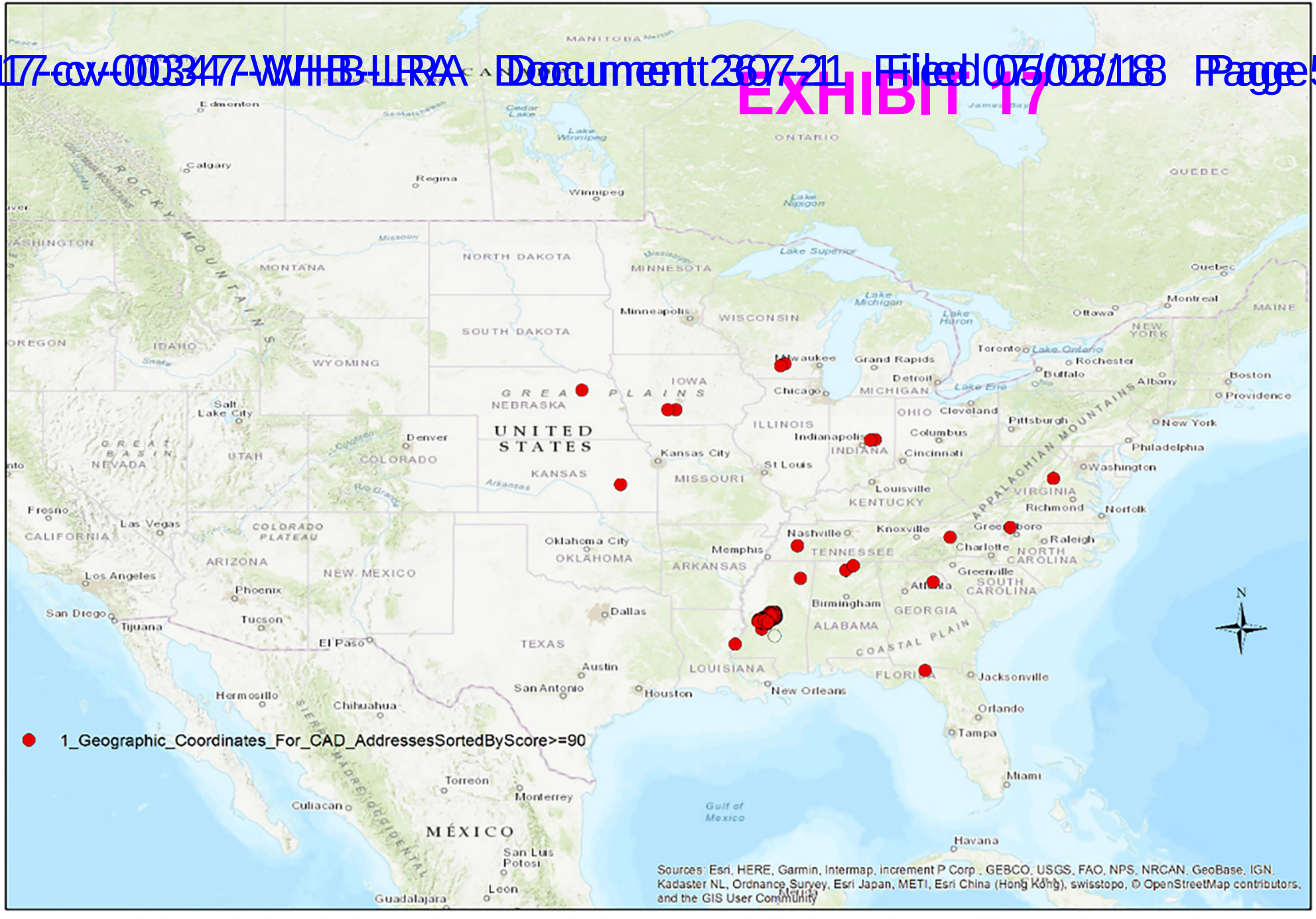
EXHIBIT 16



Nationwide Distribution of Geocoded CAD Addresses

0 150 300 600 900 1,200
Miles

EXHIBIT 17



Nationwide Distribution of Geocoded CAD Addresses With Score Greater Than or Equal to 90

0 150 300 600 900 1,200
Miles

IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF MISSISSIPPI
JACKSON DIVISION

LATOYA BROWN, et al. **PLAINTIFFS**

v. **CIVIL ACTION NO. 3:17-cv-347 WHB LRA**

MADISON COUNTY, MISSISSIPPI; et al. **DEFENDANTS**

DECLARATION OF WILLIAM R. FUNDERBURK

I, William R. Funderburk, make the following declaration based on personal knowledge:

1. I have been retained by the Defendants in the above referenced matter as expert. I submit that the foregoing report from me dated May 8, 2018 is a true and accurate copy of the report I provided to Defendants in this matter. I declare that the information and opinions contained in the report are true and correct to the best of my knowledge.

I declare under penalty of perjury that the foregoing is true and correct. 28 U.S.C. § 1746.

May 8, 2018

William R. Funderburk

EXHIBIT 2

UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF MISSISSIPPI
JACKSON DIVISION

LATOYA BROWN; LAWRENCE BLACKMON; HERBERT ANTHONY GREEN; KHADAFY MANNING; QUINNETTA MANNING; MARVIN MCFIELD; NICHOLAS SINGLETON; STEVEN SMITH; BESSIE THOMAS; and BETTY JEAN WILLIAMS TUCKER, individually and on behalf of a class of all others similarly situated,

Plaintiffs,

v.

MADISON COUNTY, MISSISSIPPI; SHERIFF RANDALL S. TUCKER, in his official capacity; and MADISON COUNTY SHERIFF'S DEPUTIES JOHN DOES #1 through #6, in their individual capacities,

Defendants.

Civil Action No.
3:17-cv-00347-WHB-LRA

REBUTTAL EXPERT REPORT OF PATRICIA FRONTIERA, Ph.D.

July 2, 2018

Table of Contents

1. QUALIFICATIONS AND ASSIGNMENT

1.1. Qualifications

1. I am a geospatial data scientist with the Social Sciences Data Lab (D-Lab) at the University of California Berkeley. The D-Lab provides research support to graduate students, advanced undergraduates, faculty and other scholars on methods and tools for computational data analysis. In my position at the D-Lab I lead our geospatial topic area which entails developing and teaching workshops on a wide variety of topics related to geospatial data, mapping and spatial analysis as well as consulting with individuals and on research projects in this domain. I have been with the D-Lab since August 2014.

2. Geocoding is one of my areas of expertise at the D-Lab. Since 2015 I have developed and taught over 12 workshops on geocoding using the ArcGIS, the Google Maps API, the Census Geocoding API as well as methods for geocoding in the R and Python programming languages. I regularly consult with researchers on geocoding strategies and tools, averaging one such consult per month, many of which extend over multiple visits.

3. In addition to my position at the D-Lab I have taught courses on geospatial data analysis as a lecturer University of California Berkeley for the departments of Landscape Architecture & Environmental Planning, Environmental Science, and Policy Management and the newly formed Division of Data Science. As a lecturer for the Division of Data Science I created one of the first, if not the first, undergraduate introduction to geographic data course using the Python programming language in the U.S.

4. My professional and academic work has involved geographic data and ESRI products such as ArcGIS since 1996 when I joined the staff of the UC Berkeley Center for Environmental Design research as a research programmer. I earned my Ph.D. in Environmental planning from UC Berkeley where my thesis explored the use of generalized coordinate representations in geographic information retrieval.

5. After my Ph.D. and prior to joining the D-Lab, I was a senior GIS technology specialist for the San Francisco Estuary Institute, a non-profit focused on improving the health and resiliency of aquatic habitats in the Bay Area. In this position I

created several web-based mapping tools that incorporated geocoding functionality to map locations by place names and addresses.

6. My CV is attached as Appendix A to this report and includes a detailed list of my professional and academic work including conference presentations and publications.

7. I have never testified as an expert. I am providing my services in this matter at a rate of $250/hour.

1.2. Assignment

8. I have been asked by counsel for Plaintiffs to review the reports of Mr. Funderburk and Dr. Ricchetti, and comment on Mr. Funderburk's opinions about the location data produced in this case by the Madison County Sheriff's Department and the geocoding done by Dr. Ricchetti.

1.3. Summary of Findings

9. I have reviewed the reports of Dr. Ricchetti and Mr. Funderburk. In this report, I evaluate the geocoding performed in Dr. Ricchetti's initial report, and respond to several of the claims by Mr. Funderburk about this geocoding and its use in Dr. Ricchetti's analysis. I find that Dr. Ricchetti's initial report followed best practices resulting in a high level of overall geocoding quality. Specifically, Dr. Ricchetti geocoded locations with ArcGIS, a widely used geocoding software package, using standard and accepted techniques.

10. I further find that Mr. Funderburk frequently overstates many of his claims. He concludes that Dr. Ricchetti's geocoding is not accurate, precise, or reliable but does not support these conclusions with standard geocoding evaluation practices or statistical analysis. Mr. Funderburk's misstatements appear to stem from (1) a failure to consider the ultimate purpose of Dr. Ricchetti's geocoding, (2) a failure to meet the academic standard of a randomized evaluation, and (3) a lack of familiarity with the academic literature surrounding geocoding best practices.

11. Contrary to what Mr. Funderburk implies in his report, neither a geographer nor a geospatial professional is needed to successfully geocode roadblock locations with ArcGIS. ArcGIS and other software for working with geographic information are used in a wide variety of professions and academic disciplines. On a regular basis, I

teach and consult with epidemiologists, planners, economists, historians, sociologists, political scientists, humanists, linguists, computer scientists, and legal scholars, among others, who successfully use ArcGIS and geocoding in their work without being experts in either. Because of this, I do not agree with Mr. Funderburk's contention that Dr. Ricchetti needed to retain an expert geographer or geospatial professional in order to obtain reliable and accurate geocoded locations from ArcGIS.

12. Mr. Funderburk's claims that street intersections cannot be accurately geocoded are contrary to my own experience and to the numerous academic studies in which these data are accurately geocoded and the resulting locations used in analyses. In particular, this practice is widely used in transportation research and public health research that investigates vehicle and pedestrian accidents.

13. Contrary to Mr. Funderburk's claims, a geocoding match score is a standard metric for evaluating the quality of geocoded locations. Higher thresholds for match scores are associated with an overall higher level of geocoding accuracy and precision. Dr. Ricchetti's analysis used a conservatively high threshold of 90 relative to thresholds used in academic papers.

14. The research literature is clear that geocoding accuracy must be evaluated relative to the application in which it is being applied. Dr. Ricchetti's analysis uses the geocoded output to identify census tracts in which roadblocks are located. Mr. Funderburk's claim that the positional accuracy of Dr. Ricchetti's geocoding is insufficient to identify the census tract in which a roadblock was located is not supported by my review of the data or published academic work.

15. Mr. Funderburk identifies purported flaws in Dr. Ricchetti's analysis that are not in fact flaws and fails to demonstrate how these purported flaws are material to Dr. Ricchetti's analysis. Specifically, most of the purported flaws in geocoding Mr. Funderburk identifies are in fact ostensible errors in the underlying data, not errors in geocoding. Mr. Funderburk also expounds on the need for coordinate reference system alignment but does no analysis to show how this impacts the overall results of Dr. Ricchetti's analysis. I discuss below why this is not an issue in the analysis.

16. Mr. Funderburk claims that roadblocks located in streets that are also census tract boundaries invalidate Dr. Ricchetti's analysis, yet again he offers no analysis to support this. Rather, I confirm the accuracy of Dr. Ricchetti's census tract

boundaries and perform analysis to show that the method Dr. Ricchetti uses to associate roadblocks with census tracts was reliable, and that any incremental error in the assignment of roadblocks on census tract boundaries to specific tracts likely resulted in undercounting number of roadblocks within census tracts with a relatively high black population percentage. Thus, this purported issue in fact makes Dr. Ricchetti's results likely conservative.

2. ARCGIS IS A WIDELY USED TOOL IN ACADEMIC RESEARCH

17. ESRI's ArcGIS is a widely used tool for geocoding data for statistical analysis. Research articles that compare geocoding tools almost always include a review of ArcGIS, or its predecessor ArcView, indicating its prominent use.[1] There are few commercial alternatives that offer the same level of ease of use, input customization, both on-premise and online environments, and high output quality. The Google Geocoding API produces comparable output quality but with the tradeoff that a programming interface is required (no graphical user interface).[2]

18. Geocoding with ArcGIS is widely used because it is very highly regarded. ESRI is one of the oldest GIS software companies and its business is focused on creating software tools for geographical data, analysis, and mapping. This focus has allowed ESRI many years to progressively refine and improve their products, efforts from which I have benefited greatly over the last 18+ years as these tools evolved from ArcView 3.1 to 10.5.1. In short, ESRI's ArcGIS suite of tools and related data products are the de facto standard for geocoding in academic teaching and research, commanding a dominant share of the commercial market as well.[3]

19. There is an extensive body of literature on the successful application and evaluation of geocoding by leading scholars in a variety of fields including public health, epidemiology, city and regional planning, transportation, public safety, economics, and sociology, among others. For example, the multi-year Harvard Public Health Disparities Geocoding Project produced a number of articles that demonstrate the effectiveness of geocoding health data and associating it with census tract-level demographic data in order to better understand and improve socio-economic disparities in access to healthcare.[4] The journal *Spatial and Spatio-temporal*

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[1] For example, see Zandbergen, Paul A., "Geocoding Quality and Implications for Spatial Analysis," *Geography Compass*, 3(2), 2009, pp. 647–680.

[2] Roongpiboonsopit, Duangduen and Hassan A. Karimi, "Comparative Evaluation and Analysis of Online Geocoding Services," *International Journal of Geographical Information Science*, 24(7), 2010, pp. 1081–1100.

[3] Duncan, Dustin T., et al., "Evaluation of the Positional Differences Between Two Common Geocoding Methods," *Geospatial Health*, 5(2), 2011, p. 266.

[4] "The Public Health Disparities Geocoding Project Monograph: Executive Summary," available at Harvard T.H. Chan School of Health, https://www hsph.harvard.edu/thegeocodingproject/executive-summary; Krieger, Nancy et al., "Geocoding and Monitoring of US Socioeconomic Inequalities in Mortality and Cancer Incidence: Does the Choice of Area-based Measure and Geographic Level Matter?," *American Journal of Epidemiology*, 156(5), 2002, pp. 471–482.; Krieger, Nancy, "A Century of Census Tracts: Health & the Body Politic (1906 –2006)," *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 83(3), 2006, pp. 355–361.

Epidemiology dedicated a special issue to the topic of geocoding and health research.[5] Additionally, Ratcliffe evaluates the effectiveness of geocoding for crime mapping.[6] More germane to this report, Levine & Kim, Dutta et al., Bigham et al., Park, and Qin all describe effective methods for geocoding intersections where motor vehicle crashes occur.[7]

20. As I describe below, most of the geocoding critiques of Dr. Ricchetti's analysis identified by Mr. Funderburk stem from incomplete information in the data provided by MCSD rather than from geocoding errors. As I discuss below, this case also presents the issue of the existence of roadblocks on boundaries of census tracts. This is, however, not a geocoding problem and rather a geographical problem that can be assessed through a variety of robustness analyses.

21. Geocoding is the process of determining the geographic coordinates for a named place, street address, postal code, or any other non-geometric representation of a geographic location. I will limit this discussion to street address and intersection geocoding. The process is straight-forward and consistent across geocoding software. First, you undertake several steps to "clean" or standardize the data you want to geocode. This entails (1) putting your records in the file format required by your geocoding software, with either all address components in the same column or in separate columns, e.g. *street name, city, state, zip*; (2) standardizing the text format of your records, e.g. with consistent capitalization, abbreviations for streets (Ave for Avenue), and conventions such as "&" or "AND" to denote an intersection; and (3) adding as much information as possible to all records such as the city, county, state, and zip code.

22. A review of the data provided by Dr. Ricchetti to Mr. Funderburk in the table of *Compiled Unique Roadblocks* shows how this was done for these roadblock data.[8] I

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[5] *Spatial and Spatio-temporal Epidemiology*, 3(2), 2012, pp. 93–112.

[6] Ratcliffe, Jerry H., "Geocoding Crime and a First Estimate of a Minimum Acceptable Hit Rate," *International Journal of Geographical Information Science*, 18(1), pp. 61–72.

[7] Levine, Ned and Karl E. Kim, "The Location of Motor Vehicle Crashes in Honolulu: A Methodology for Geocoding Intersections," *Computational, Environmental and Urban Systems*, 22(6), 1998, pp. 557–576; Dutta, Arup, et al., "System for Digitizing Information on Wisconsin's Crash Locations," *Journal of the Transportation Research Board*, (19), 2007, pp. 256–264; Qin, Xiao, et al., "Intelligent Geocoding System to Locate Traffic Crashes," *Accident Analysis and Prevention*, 50, 2013, pp. 1034–1041; Bigham, John M., et al., "Geocoding Police Collision Report Data from California: A Comprehensive Approach," *International Journal of Health Geographics*, 8(72), 2009, pp. 1–10; Park, Shin H., et al., "Geocoding Vehicle Collisions on Korean Expressways Based on Postmile Referencing," *Journal of Civil Engineering*, 15(8), 2011, pp. 1435–1441.

[8] Report of William R. Funderburk, May, 8, 2018 ("Funderburk Report"), Appendix D.

include this table in my report as Appendix C. If you compare the values in the *original_address* column with those in the *clean_address* column you see that the street names have been formatted in upper case, with "AND" as the intersection delimiter, the county and state has been added to each address, and address components are comma delimited. Contrary to what Mr. Funderburk states, the applied cleaning process is transparent and consistent with standard practices.

23. Once the input data are "clean" they can be geocoded. Geocoding requires three key components. The first is the input data. The second is a reference database against which input locations will be compared for candidate matches. The third is the geocoding software engine that ingests the input data and uses algorithms and rules to search the reference database for matches.

24. The quality of the reference database is directly related to the output quality.[9] A reference database that is comprehensive in geographic coverage, is up-to-date, and contains a high level of spatial and attribute detail and accuracy will provide better results. Moreover, geocoding reference databases are increasingly adding multiple spatial representations against which input data can be matched including parcel polygons and center points, street centerlines, street intersection tables, and named points of interest.[10]

25. Available ArcGIS reference databases include the online World Geocoding Service, the ArcGIS Business Analyst Geocoding data, and Streetmap Premium data for ArcGIS. The latter two databases are updated annually while the online World Geocoding Service is updated more frequently. In my professional opinion the World Geocoding Service reference database is one of the best available for locations in the United States, along with the Google Geocoding API reference database.

26. ArcGIS provides a number of software tools that can geocode input data with the World Geocoding Service reference database. One approach is to use the ArcGIS Desktop software, locally installed on your computer, which provides a graphical

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[9] Goldberg, Daniel W., John P. Wilson and Craig A. Knoblock, "From Text to Geographic Coordinates: The Current State of Geocoding," *Journal of the Urban and Regional Information Systems Association*, 19(1), 2007, pp. 33–46; Zandbergen, Paul A., "Geocoding Quality and Implications for Spatial Analysis," *Geography Compass*, 3(2), 2009, pp. 647–680.

[10] Zandbergen, Paul A., "A Comparison of Address Point, Parcel and Street Geocoding Techniques," *Computers, Environment and Urban Systems*, 32(3), 2008, p. 218.

user interface to make requests to the remote service. Another approach is to write a script, or short software program, that uses an API (or application programming interface) to submit your records to be geocoded to the online ArcGIS World Geocoding Service. My review of Dr. Ricchetti's Python geocoding script shows that this latter method was used to geocode the roadblock locations with the ArcGIS World Geocoding Service.

27. In short, contrary to what Mr. Funderburk has suggested, Dr. Ricchetti used standard practices to geocode roadblock locations using one of the best, if not the best, available geocoding tools — the ArcGIS World Geocoding Service.

3. STREET INTERSECTIONS CAN BE RELIABLY GEOCODED

28. Mr. Funderburk identifies several potential areas of geocoding imprecisions in Dr. Ricchetti's analysis. Mr. Funderburk concludes that "it does not appear that the address information kept by MCSD contains enough information to perform geographic analysis such as geocoding."[11] Based on my professional experience, the types of imprecision Mr. Funderburk identifies are common in administrative data and do not render geocoding and statistical analysis of the data unreliable.

3.1. Street intersection data contain enough location information to be successfully geocoded

29. Mr. Funderburk suggests repeatedly that street intersections cannot be accurately geocoded and that this is a significant problem for Dr. Ricchetti, because 93.4% of the roadblock locations in this case are recorded at intersections rather than at exact addresses.[12] He states:[13]

> "To geocode properly, the software needs to compute the geometry of the desired point information. If we are using hard street addresses and have performed our pre-processing calibration, it is a relatively easy process. However, using intersection-only information introduces a variety of errors in geopositional accuracy and precision."

30. I strongly disagree with these assertions. As I explain above, street intersections can be and are regularly geocoded with acceptable levels of accuracy and precision.[14] Street intersection geocoding has some of the same challenges as street address geocoding such as the need for high quality geocoding software and a high quality reference database, both of which are provided by ArcGIS. Both require sufficient input information to determine a location. For a street address this includes a street number, street name, and containing locality (e.g., city, zip code, county, state, country) while a street intersection needs only the names of the two streets and the

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[11] Funderburk Report, ¶ 46.

[12] Funderburk Report, ¶ 45.

[13] Funderburk Report, ¶ 49.

[14] Levine, Ned and Karl E. Kim, "The Location of Motor Vehicle Crashes in Honolulu: A Methodology for Geocoding Intersections," *Computational, Environmental and Urban Systems*, 22(6), 1998, pp. 557–576; Dutta, Arup, et al., "System for Digitizing Information on Wisconsin's Crash Locations," *Journal of the Transportation Research Board*, (19), 2007, pp. 256–264; Qin, Xiao, et al., "Intelligent Geocoding System to Locate Traffic Crashes," *Accident Analysis and Prevention*, 50, 2013, pp. 1034–1041; Bigham, John M., et al., "Geocoding Police Collision Report Data from California: A Comprehensive Approach," *International Journal of Health Geographics*, 8(72), 2009, pp. 1–10; Park, Shin H., et al., "Geocoding Vehicle Collisions on Korean Expressways Based on Postmile Referencing," *Journal of Civil Engineering*, 15(8), 2011, pp. 1435–1441.

locality. One challenge unique to street intersection geocoding is that two streets can intersect in more than one location within the same locality, for example where a divided road intersects with another street. These cases can be easily identified, reviewed, and, if needed, resolved with the ArcGIS geocoder which will return a match type of *street intersection* with a status of *tied* for these locations.

31. Based on my experience I would argue that street intersections can be geocoded with a higher level of positional accuracy than street addresses, particularly when street address geocoding is based on interpolation, a common practice to compute coordinates for a street address based on the relative position of a street number with a street address range. For example, 50 Main St would be interpolated to the middle of a block with addresses ranging from 0 to 100. However, numerous studies have shown that linear interpolation can be quite inaccurate in areas with curved streets, cul-de-sacs, and irregularly shaped or sized parcels.[15]

3.2. Dr. Ricchetti's use of the Match Score is consistent with Standard Geocoding Practice

32. In his report Mr. Funderburk asserts that Dr. Ricchetti did not adequately assess the quality of the geocoding output.[16] He also criticizes Dr. Ricchetti's use of the match score as a measure of geocoding quality and accuracy.[17] I comment on both of these below.

33. Geocoding quality is most commonly evaluated in terms of match rate and positional accuracy.[18] Match rate refers to the percent of total input records for which the geocoder found a successful match. ArcGIS, and other geocoding software, will return a match status of matched, tied, or unmatched for each location input to the geocoder to indicate whether or not the software was able to find a match in the reference database.

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[15] For example, see Goldberg, Daniel W., John P. Wilson, and Craig A. Knoblock, "From Text to Geographic Coordinates: The Current State of Geocoding," *Journal of the Urban and Regional Information Systems Association*, 19(1), 2007, pp. 33–46.

[16] Funderburk Report, ¶¶ 17, 32, 60.

[17] Funderburk Report, ¶¶ 67–69

[18] Abe, Toshi, and David Stinchcomb, "Geocoding Practices in Cancer Registries," Gerard Rushton et al., (Eds.), *Geocoding Health Data: The Use of Geographic Codes in Cancer Prevention and Control, Research and Practice*, CRC Press, Boca Raton, Florida, 2008, pp. 111–125; Zandbergen, Paul A., "Geocoding Quality and Implications for Spatial Analysis," *Geography Compass*, 3(2), 2009, p. 652.

34. A match score threshold is then commonly used as an indicator of a successful match. According to the documentation for the ArcGIS World Geocoding Service the match score is:[19]

> "A number from 1–100 indicating the degree to which the input tokens in a geocoding request match the address components in a candidate record. A score of 100 represents a perfect match, while lower scores represent decreasing match accuracy. Score is always returned by default."

35. The match score is a measure of a degree to which an input address was matched to data in the reference database. The higher the score the greater the degree to which the values match.

36. Schootman states in a journal article specifically evaluating geocoding quality that addresses "with a match score of 75 or more were considered a good match."[20] Yang discusses setting a minimum match score to 80 to improve geocoding results.[21] Dr. Ricchetti conservatively requires a match score of at least 90.[22]

37. Positional accuracy refers to the distance between the geocoded location and the real location.[23] For example, if the geocoded point represents a street address then the shortest distance between the point and the boundary of the property would be the positional accuracy.

38. The level of positional accuracy deemed acceptable varies depending on the specific application.[24] For example, in a study of vehicle collisions, Bigham defines

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[19] "Service Output," available at *ArcGIS for Developers*, https://developers.arcgis.com/rest/geocode/api-reference/geocoding-service-output.htm.

[20] Schootman, Mario, et al., "Positional Accuracy and Geographic Bias of Four Methods of Geocoding in Epidemiologic Research," *Annals of Epidemiology,* 17(6), 2007, pp. 464–470.

[21] Yang, Duck-Hye, et al., "Improving Geocoding Practices: Evaluation of Geocoding Tools," *Journal of Medical Systems*, 28(4), 2004, pp. 361–370.

[22] Deposition of Bryan Ricchetti, Ph.D., April 6, 2018 ("Ricchetti Deposition"), p. 168:4–10.

[23] Zandbergen, Paul A., "Geocoding Quality and Implications for Spatial Analysis," *Geography Compass*, 3(2), 2009, p. 652.

[24] Zandbergen, Paul A., "Geocoding Quality and Implications for Spatial Analysis," *Geography Compass*, 3(2), 2009, pp. 663–666.

positionally accurate geocoding as any geocoded point within 50 feet of the real world location as depicted on Google Earth Pro imagery.[25]

39. The match score is also used as an indicator of positional accuracy.[26] Duncan reports that only "geocoded addresses with the highest positional accuracy (as defined by a match score of ≥ 80)" were included in his study.[27] According to Zandbergen, "lowering the minimum match score results in a decrease in accuracy and therefore geocoding quality," which implies that the inverse is true – raising the minimum match score improves geocoding accuracy and quality.[28]

40. Other measures of geocoding quality include reliability and precision. Reliability is primarily a qualitative measure of the degree of confidence in the geocoding results based on the reputability of the software vendor and the geocoding reference database.[29] As discussed previously, ArcGIS geocoding software and reference databases are highly regarded and widely used.

41. Geocoding precision is a measure of the variance in positional accuracy. While positional accuracy is quantified as the measured distance between geocoded points and real locations, precision refers to the difference between those distances and the average distance for the data set as a whole. If match score is used as an indicator of positional accuracy, then variation in match scores can be used to evaluate precision. Moreover, to the extent that a high minimum match score increases geocoding accuracy it would also likely increase precision.

42. In short, contrary to Mr. Funderburk's claims, Dr. Ricchetti did evaluate the overall quality of the geocoding output. His evaluation was based on the geocoding match

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[25] Bigham, John M., et al., "Geocoding Police Collision Report Data from California: A Comprehensive Approach," *International Journal of Health Geographics*, 8(72), 2009, pp. 1–10.

[26] Goldberg, Daniel W., "A Geocoding Best Practices Guide," *The North American Association of Central Cancer Registries,* 2008, p. 98.

[27] Duncan, Dustin T., et al., "Evaluation of the Positional Difference Between Two Common Geocoding Methods," *Geospatial Health*, 5(2), 2011, p. 272.

[28] Zandbergen, Paul A., "A Comparison of Address Point, Parcel and Street Geocoding Techniques," *Computers, Environment and Urban Systems,* 32(3), 2008, p. 218.

[29] Goldberg, Daniel W., "A Geocoding Best Practices Guide," *The North American Association of Central Cancer Registries*, 2008, p. 98.

rate and match score, both of which are standard metrics of overall geocoding. The use of the match score in Dr. Ricchetti's report is consistent with standard practice.

3.3. Mr. Funderburk's Assessment of Geopositional Accuracy is Flawed

43. In contrast, in his report Mr. Funderburk does not use standard geocoding practices to evaluate the geocoding results used in Dr. Ricchetti's study. Note, Mr. Funderburk uses the term "geopositional accuracy" in his report whereas I use the term "positional accuracy" to be consistent with the geocoding literature.

44. In his report, Mr. Funderburk argues that the use of a high match score is not an indicator of geocoding quality.[30] He supports this claim by overlaying 25,335 geocoded points from Dr. Ricchetti's analysis with a match score greater than or equal to 90 onto a map of the continental United States.[31] Because this map displays geocoded points that are located outside of Madison County, Mr. Funderburk concludes that Dr. Ricchetti's geocoding shows extreme errors and is evidence of improper geocoding.[32] However, Mr. Funderburk does not quantify those errors in order to substantiate his conclusion.

45. In my analysis of those points, only 204 of 25,335 points, or 0.8%, were located outside of Madison County. In my professional opinion, that percentage is an indicator of a very high level of geocoding quality, consistent with Dr. Ricchetti's use of the match score.

46. Separately from his critique of data points with a match score above 90, Mr. Funderburk presents an "incomplete" (by his own admission)[33] and statistically biased assessment of the positional accuracy of the geocoded roadblock locations in Dr. Ricchetti's report. From this, he concludes without foundation that there are "countless erroneously geocoded locations."[34] His assessment is based on a review of a small subset of the geocoded locations that he undertook with Deputy Rylon

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[30] Funderburk Report, ¶¶ 66–70.

[31] Funderburk Report, Figure 4.

[32] Funderburk Report, ¶¶ 69–70.

[33] Funderburk Report, ¶ 48.

[34] Funderburk Report, ¶ 16.

Thompson. Mr. Funderburk claims that this review employed a method called "ground truthing."[35]

47. First, I will review the method of ground truthing as it is applied to the evaluation of positional accuracy in geocoding. Then I will describe how Mr. Funderburk did not adequately employ this method and therefore cannot assess the overall positional accuracy of Dr. Ricchetti's geocoding.

48. Ground truthing is a widely used method for evaluating the accuracy and precision of geocoded results.[36] In geocoding applications, the method refers to the process of comparing geocoded point locations to the location of the real world features they represent. Coordinates for the real world feature are obtained by (1) physically visiting the site and using a GPS; (2) reviewing the site on high-resolution imagery such as Google Maps or Google Earth satellite imagery; or less typically (3) from a database of known coordinate locations.

49. Ground truthing requires that a statistically random sample of the geocoded points be selected for review.[37] Random in the statistical sense means that any observation has the same chance of being selected for review. Random sample sizes discussed in the geocoding literature vary depending on the goals of the analysis at hand and typically range from 1%[38] to 5%.[39]

50. For each selected point the Euclidean distance between the geocoded and real world coordinates is measured. The distance would then be recorded for each pair of points. The overall positional accuracy of the geocoding would then be determined based on the average or median distances between the geocoded points reviewed and the location in the real world.

51. It is important to note that points are simplistic representations of complex, real world geographic features such as a parcel boundaries, structures, street

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[35] Funderburk Report, ¶¶ 12, 46–48.

[36] Goldberg, Daniel W., "A Geocoding Best Practices Guide," *The North American Association of Central Cancer Registries*, 2008, p. 104.

[37] For example, see Zhan, F.B. et al., "Match Rate and Positional Accuracy for Two Geocoding Methods for Epidemiologic Research," *Annals of Epidemiology*, 16(11), 2006, p. 845.

[38] Qin, Xiao, et al., "Intelligent Geocoding System to Locate Traffic Crashes," *Accident Analysis and Prevention*, 50, 2013, p. 1039.

[39] Duncan, Dustin T. et al., "Evaluation of the Positional Difference Between Two Common Geocoding Methods," *Geospatial Health*, 5(2), 2011, p. 267.

intersections, and roadblocks, all of which have features such as size, shape, and orientation that cannot be captured by a point. Given this inherent generalization, positional accuracy is evaluated relative to a point location *within* or *near* the real world geographic feature it represents, for example the center point of a parcel street intersection. Therefore, the process of evaluating positional accuracy requires the documentation of this evaluative criteria.

52. Moreover, because a point is a simplistic representation of a real world geographic feature, ground truthing and accuracy assessment require knowledge of the real world feature under study in order to identify its location on a map or in the field. In this case that would be a person with first-hand knowledge of the location of the roadblocks.

53. The ground truthing analysis as conducted by Mr. Funderburk and Deputy Thomson was flawed for at least two reasons. First, Mr. Funderburk did not review with Deputy Thompson a random sample of the geocoded locations. Second, Mr. Funderburk compared locations geocoded by Dr. Ricchetti to the locations where Deputy Thompson believed the roadblocks physically existed, not to the physical locations on the ground representing the addresses in the *Compiled Unique Roadblocks*. Any discrepancy in Dr. Ricchetti's analyses of this type would be due to imprecise address recording in the *Compiled Unique Roadblocks* by the sheriff's department, not due to geocoding errors. Therefore, whatever the results of his analysis, they cannot be used to draw conclusions about either the positional accuracy or overall quality of the geocoding results.

54. Moreover, I would argue that there is statistical bias in the points that were selected for review.[40] I say this because a visual review of a map of the geocoded locations will naturally draw one's eyes to the errors, be they few or many, rather than the correct locations. We saw that to be the case in Mr. Funderburk's use of Figure 4 in his report, which I discussed previously.

55. Mr. Funderburk did not define and use a consistent evaluative criteria for positional accuracy. He did not state what constituted an accurately located roadblock, e.g. within 10 meters of the center of the intersection in which it was located. Additionally, Mr. Funderburk did not measure the distance between each of the

[40] Deposition of William R. Funderburk, June 20, 2018 ("Funderburk Deposition"), pp. 42:24–44:14.

reviewed geocoded points and the locations of the roadblocks that they represent and use those distances to compute an overall metric of positional accuracy.

56. Mr. Funderburk's report implies that Deputy Thompson is familiar with the location of the roadblocks under study and thus provides the local knowledge needed to ground truth geocoded locations.[41] However, he did not confirm that Deputy Thompson was in fact present at all of the roadblocks that they reviewed together or take any other steps to verify the accuracy of Deputy Thompson's recollections.[42] Therefore, I cannot tell if Deputy Thompson indeed had the local knowledge needed to ground truth the roadblock locations.

57. Additionally, it is clear that Deputy Thompson brought to Mr. Funderburk's review process additional knowledge about roadblock locations that was not included in the information provided as the input to the geocoding software for some of the roadblocks. For example, when describing his Exhibit 1, Mr. Funderburk states "Point No. 18 should be 0.21 miles north on Harbor Drive". The location listed for point 18 that was used to geocode is "HARBOR AND LAKE HARBOR, MADISON COUNTY, MS".[43] The geocoded point is shown below on a screen shot of Mr. Funderburk's Exhibit 1 as a green circle at that very intersection, indicative of an accurate geocoding result, where I use accurate to mean within the intersection.

[41] Funderburk Report, ¶ 46.

[42] Funderburk Deposition, p. 39:6–12. ("Q. When you interviewed Deputy Thompson, did he confirm to you that he had been present at each of the roadblocks that had been plotted in Dr. Ricchetti's report? A. He was present at the roadblocks that are in my exhibits. I can't attest to if he was present at every roadblock in Dr. Ricchetti's report.")

[43] Funderburk Report, ¶ 48, Appendix D.

EXHIBIT 1

Replication of Funderburk Exhibit 1

Source: Funderburk Report

Note: From Funderburk Exhibit 1. Image depicts the geocoded location of Roadblock Point 18 (green circle) and the roadblock's "actual" location (X)

58. Yet, Mr. Funderburk presents this as an example of an incorrectly geocoded location because Deputy Thompson states that the "real" location of the roadblock was at the intersection of W. Ramp Rd. and Harbor Dr.[44] If that were to be true then this is not a geocoding error but rather an error in the underlying data produced in this case – i.e., whoever at the sheriff's department was responsible for reporting or recording the location of the roadblock did so incorrectly or imprecisely. Data

[44] Funderburk Report, ¶ 48, Exhibit 1.

recording errors are present in most geocoding input data and do not invalidate the use of such databases.

59. I reviewed the point locations discussed by Mr. Funderburk in Exhibits 1–11 of his report.[45] My evaluation is shown in my Exhibit 2 below. Ten of the 22 points he presents as evidence of geocoding errors or incorrect census tract assignments are of the nature described above – a discrepancy between the location listed in the table and what Deputy Thompson claimed was the true location of the roadblock. Four are data input errors. Three do not include sufficient address information. Four concern the assignment of roadblocks to census tracts, which I discuss in more detail below in Section 3.5. Only one point could be considered a geocoding positional accuracy error.

EXHIBIT 2

Taxonomy of Errors Asserted for the 22 Points Reviewed by Mr. Funderburk and Claimed to Demonstrate Inaccurate Geocoding, From Funderburk Report, Paragraph 48 and Corresponding Exhibits 1-11

Type of Error Asserted	Description	Point Numbers	Number of points
Bad Data Input	Deputy Thompson's location for the roadblock differs from that listed in the table of Compiled Unique Roadblocks	18, 53, 141, 215, 14, 203, 98, 129, 151, 161	10
Bad Data Input	Typos, abbreviations, or incorrect data input	77, 244, 12, 193	4
Insufficient Address Information	Data input lacked a street address or intersection	159, 287, 3	3
Boundary	Census tract boundary assignment discussed	344, 51, 11, 67	4
Low positional accuracy	Geocoded point evaluated as too far from actual location	100	1

[45] Funderburk Report, ¶ 48, Exhibit 1–11.

60. Mr. Funderburk bases his assessment of positional accuracy on the assumption that Deputy Thompson's assertions regarding the roadblock locations, and not the addresses and street intersections listed for each roadblock in the table of *Compiled Unique Roadblocks,* identifies their true location. Even if Deputy Thompson's recollection is correct that actual roadblock locations differ from the table of *Compiled Unique Roadblocks* for the limited sample of observations he considered, which I cannot assess, these findings would not necessarily be representative of the data set as a whole because the locations were not selected randomly.

61. It is my professional opinion, based on the above discussion, that Mr. Funderburk's ground truthing process was not performed in accordance with geocoding standard practices. His sample was not random, his process was not documented nor consistently applied, and his knowledge of the true location of roadblocks was based on his interview with Deputy Thompson which was not substantiated. Further, the purported geocoding errors he identifies are, in fact, not geocoding errors. They are either data errors or reliably geocoded roadblocks located on or near census tract boundaries (which I discuss in detail in Section 3.5). Thus, his analysis does not support his conclusions that Dr. Ricchetti's geocoding contains "a variety of errors in geopositional accuracy and precision."[46]

3.4. Coordinate Reference System Issues do not significantly impact the analysis of Roadblock locations

62. In section 4.4 of his report, Mr. Funderburk asserts that issues related to coordinate reference systems undermine the quality and validity of Dr. Ricchetti's analysis. I find this to be untrue and discuss my reasoning below.

63. Geographic coordinates expressed as longitude and latitude can be identical and yet reference two different physical real world locations if they are referenced to different datums. There are currently two families of datums in widespread use for geographic locations in the United States. These are the North American Datum of 1983 (NAD83) and the World Geodetic System of 1984 (WGS84). The ArcGIS World Geocoding Service, which was used by Dr. Ricchetti, returns geocoded

[46] Funderburk Report, ¶ 49.

results in the WGS84 datum.[47] Census tract boundary spatial data files, called TIGER Files, are distributed with geographic coordinates referenced to NAD83.

64. For the continental United States, the positional difference in WGS84 and NAD83 coordinates varies from one meter to four meters depending on the version of the datums used. For applications that require less than three meter accuracy, transformations between these two datums are not recommended as those transformations can introduce additional error.[48] In other words, it is common practice to treat WGS84 and NAD83 geographic coordinates as though they were referenced to the same coordinate reference system.

65. Dr. Ricchetti's analysis does not require sub-three meter positional accuracy to identify the census tract in which a roadblock represented by a point resides. This is because census tract boundaries do not have sub-three meter positional accuracy. In fact the US Census does not publish the positional accuracy of census tract geographic data.[49] We can also safely assume that the geocoded roadblocks do not have sub-three meter positional accuracy since the street intersections and street addresses against which they are geocoded are typically more than three meters wide in one dimension.

66. WGS84 and NAD83 are both three-dimensional geographic coordinate systems. Geographic coordinates are often transformed to a two-dimensional projected coordinate system before any spatial analysis is undertaken. This transformation is required if the spatial analysis includes distance-based measurements or if the study area is global or near the North Pole or South Pole.

67. Dr. Ricchetti's spatial analysis did not involve distance-based measurements. His analysis only considered the topological spatial relationships between census tract polygons and roadblocks.

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[47] "Service Output," available at *ArcGIS for Developers*, https://developers.arcgis.com/rest/geocode/api-reference/geocoding-service-output htm.

[48] Fromhertz, Pamela, "Datums and Tools to Connect Geospatial Data Accurately," *National Oceanic and Atmospheric Administration*, June 20, 2012, available at https://www ngs noaa.gov/web/science_edu/presentations_library/files/usgs_css_brownbag20june2012final.pdf.

[49] "Positional Accuracy of TIGER/Line Data," available at *U.S. Census Bureau*, https://www.census.gov/geo/landview/lv6help/pos_acc html.

68. Based on the above, it is my professional opinion that coordinate reference system differences between the NAD83 census tract data and the WGS84 geocoded roadblock points did not play a significant role in Dr. Ricchetti's analysis.

3.5. The relevance of roadblocks located on the boundary between census tracts can be tested using standard methods

69. Mr. Funderburk incorrectly states that, because 23% of the roadblock locations are located on census tract boundaries, any analysis based on the assignment of these roadblocks to a specific census tract should be rendered invalid.[50] Below, I will show why this claim is incorrect.

70. Data collected within and aggregated to census tracts are widely used in research to assess the socio-economic characteristics of populations within a study area. The *Harvard Public Health Disparities Geocoding Project* is a multi-year research effort that in numerous publications describes the effective use of associating data collected at geocoded locations with census tract data to assess disparities in access to health care.[51] According to project director Dr. Nancy Krieger:[52]

> "Census tracts not only provide a stable geographic unit for estimating the number and characteristics of the people and housing units located within them, but they have also expanded scientific understanding of the impact of context on the social patterning of the public's well-being, with obvious policy relevance."

71. Geocoded locations are most commonly associated with census tract data through a process known as "point-in-polygon" overlay.[53] This method entails locating geocoded points and census tract boundaries within the same coordinate space (i.e. coordinate reference system). If numerous points (for example, roadblocks) fall within a region (such as a census tract), the data for the region can be matched to

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[50] Funderburk Report, ¶ 58.

[51] For a general summary, see "The Public Health Disparities Geocoding Project," available at Harvard T.H. Chan School of Public Health, https://www hsph.harvard.edu/thegeocodingproject.

[52] Krieger, Nancy, "A Century of Census Tracts: Health & the Body Politic (1906–2006)," *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 83(3), 2006, pp. 355–361.

[53] Schootman, Mario, et al., "Positional Accuracy and Geographic Bias of Four Methods of Geocoding in Epidemiologic Research," *Annals of Epidemiology*, 17(6), 2007, p. 465.

the total number of points. This approach was used by Dr. Ricchetti to count the number of roadblocks within each census tract.

72. There are a number of articles that discuss the challenges of using point-in-polygon overlay to associate census tract data with geocoded points.[54] There are two key factors: (1) the quality of geocoded locations and (2) the correct assignment of points to census tract polygons. As I have already discussed (1), I focus on (2) below.

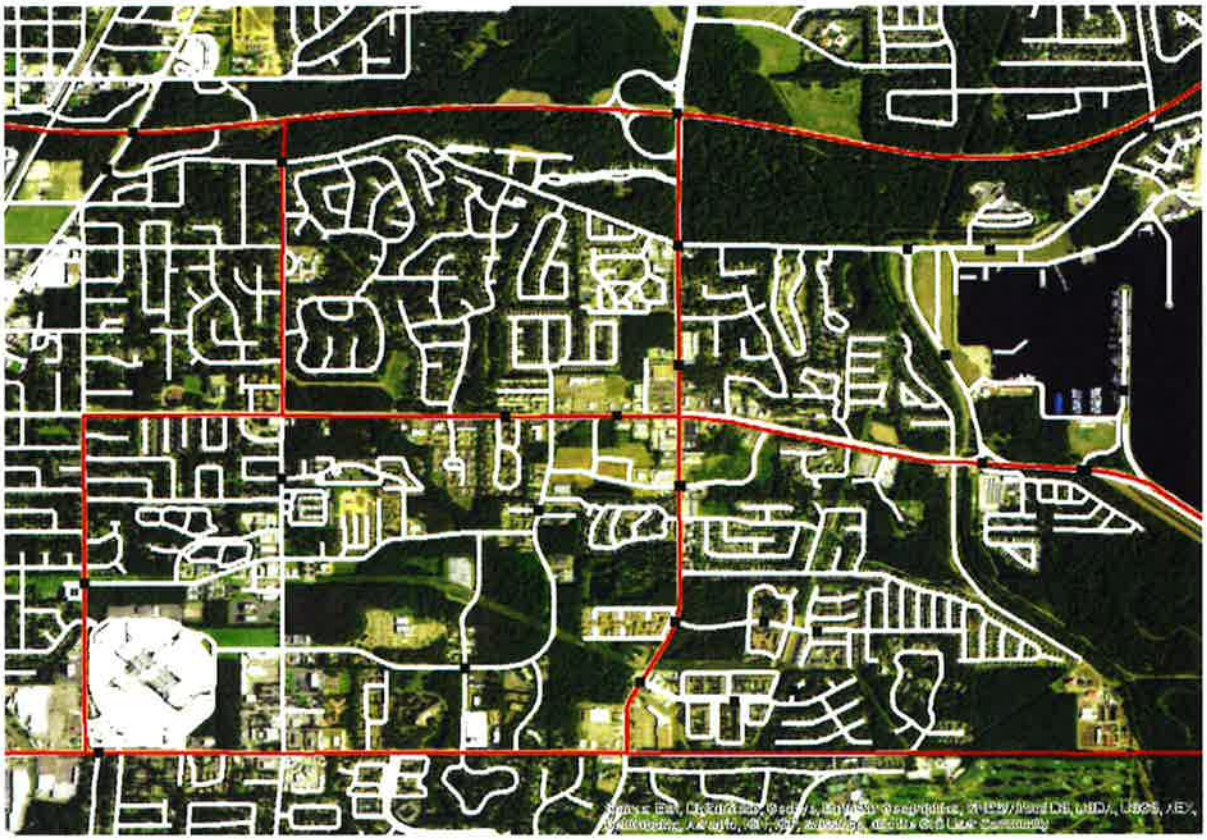
73. A key determinant of correct assignment is one of alignment – whether the spatial accuracy of the census tract boundary data supports the accurate identification of points that fall within those tracts. One method to assess this is to display the census tract data on top of aerial imagery and street network data and review the alignment of census boundaries with the street network and other linear features. This will reveal if there are major discrepancies.

74. I undertook this visual review in ArcGIS 10.5.1 using the ESRI Streets base layer and the Business Analyst 2017 geocoding data streets layer. I zoomed in and followed the census tract boundaries. I carefully examined the census boundaries depicted in Exhibit 2 of Dr. Ricchetti's report that delineate adjacent tracts characterized by a higher and lower black population percentage. Throughout the county I viewed a high degree of concordance between the tract boundaries and the street and water features. A map depicting this alignment is shown below.

[54] Schootman, Mario, et al., "Positional Accuracy and Geographic Bias of Four Methods of Geocoding in Epidemiologic Research," *Annals of Epidemiology*, 17(6), 2007, pp. 464–470; Goldberg, Daniel W., John P. Wilson and Craig A. Knoblock, "From Text to Geographic Coordinates: The Current State of Geocoding," *Journal of the Urban and Regional Information Systems Association*, 19(1), 2007, pp. 33–46; Zandbergen, Paul A., "Geocoding Quality and Implications for Spatial Analysis," *Geography Compass*, 3(2), 2009, pp. 647–680.

EXHIBIT 3

Map Showing the Alignment of Census Tract Boundaries, Major Streets and Streams, and Roadblock Locations within Madison County.



Source: Census TIGER Line Tract boundary data for Madison County, 2015; ArcGIS Business Analyst.

75. Based on this visual analysis and my professional experience, I conclude (1) that the census tracts align well with the ArcGIS street network and (2) census tract – street alignment issues would not result in roadblock points being assigned to incorrect census tracts unless those points were near a census tract boundary. As shown in the map above, and as reported by Mr. Funderburk, certain roadblock locations are near or along census tract boundaries. This is not an error. It is a

product of the fact that (1) the roadblocks are located on streets and (2) street centerlines are used to form census tract boundaries.[55]

76. Separate from the issue of tract boundary accuracy, Mr. Funderburk claims that the existence of some roadblocks close to the boundary of two or more tracts renders the analysis invalid.[56] As I explain below, the fact that roadblocks occur in streets that are also census tract boundaries does not render those roadblocks invalid for Dr. Ricchetti's analysis. However, the co-occurrence raises the following questions: (1) how many roadblocks are located on census tract boundaries? (2) how were these roadblocks assigned to census tracts in Dr. Ricchetti's analysis? and (3) what impact did his assignment of these roadblocks have on his analysis? I address these questions below in a geospatial analysis of the data.

77. First, I used ArcGIS 10.5.1 to transform the census tract boundary data and the geocoded point data, listed in the *Compiled Unique Roadblocks* table, to the Mississippi Transverse Mercator NAD83 projection (EPSG:3814). This is the projected coordinate reference system used by MARIS: the Mississippi Automated Resource Information System, a governmental organization tasked with coordinating geographic information data sets in the state.[57] This was done in order to (1) put all data in the same coordinate reference frame and (2) put all data in a projected (Euclidean) coordinate reference frame that supports distance-based queries and calculations.

78. I then converted the Madison County census tract polygon data to line data using the ArcGIS *Polygon-to-Line* tool. Next, I used the ArcGIS *Select-by-Location* tool to identify all roadblock points located on census tract boundary lines. This operation returned zero results – in other words, none of the roadblock points spatially intersect census tract boundaries, which is consistent with Dr. Ricchetti's analysis.

79. This result is not surprising. Census tract data and reference databases used to geocode locations are created by different organizations using different software at different times with different methods. Therefore, point representations of

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[55] "2017 TIGER/Line Shapefiles Technical Documentation," available at *U.S. Census Bureau*, https://www2.census.gov/geo/pdfs/maps-data/data/tiger/tgrshp2017/TGRSHP2017_TechDoc_Ch1.pdf.

[56] Funderburk Report, ¶ 58.

[57] *Mississippi Automated Resource Information System*, http://www maris.state.ms.us.

roadblock locations are highly unlikely to spatially intersect census tract boundaries even if they reside within a street whose centerline forms a census tract boundary. These points will almost always be on one side of the tract boundary line.

80. This is not an issue specific to these data. Consequently, point-line spatial intersection is typically implemented within a buffer tolerance setting to capture the nature of the real world intersection of the phenomena under study.

81. For these data, I re-ran the spatial selection query using a 20 meter (65.6 feet) buffer distance around the census tract boundary lines. Any point within 20 meters of a census tract boundary line would return TRUE for intersecting with that line. The 20 meter buffer distance is specific to this application. This distance is designed to approximate the maximum width of a two-lane street with parking on both sides given that most lane widths vary from approximately three to five meters (9 to 15 feet).

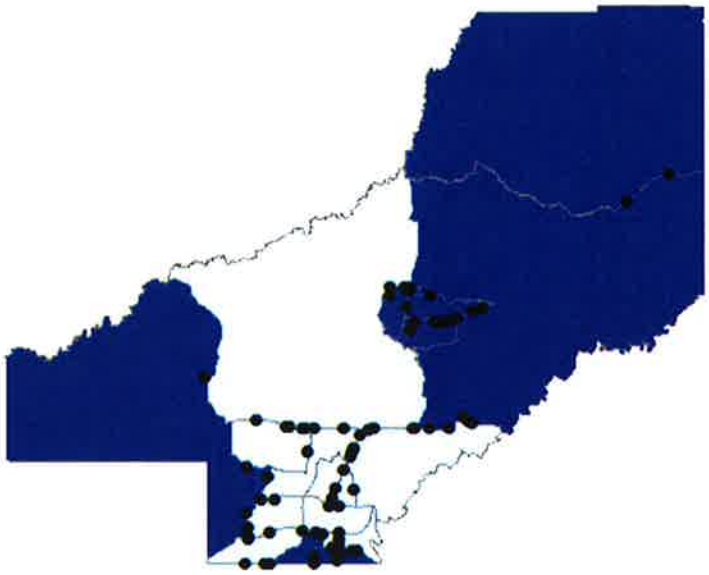
82. The spatial selection query identified 82 roadblock points representing 662 roadblocks within 20 meters of a census tract boundary line. These values are consistent with Mr. Funderburk's findings.[58]

83. The map below shows the location of these border roadblocks relative to the census tract classification scheme used in Exhibit 2 of Dr. Ricchetti's report which clearly demarks census tracts with a relatively higher black population percentage (dark blue) or relatively lower black population percentage (light blue). It is worth noting that four of the purported boundary roadblocks identified by Mr. Funderburk – accounting for 121 roadblocks – are on the border between a single census tract in Madison County and another tract *outside* Madison County. Thus, there is no uncertainty about the assignment to the relevant census tracts for these roadblocks.

[58] Funderburk Report, ¶ 57.

EXHIBIT 4

Roadblocks within 20 meters of Census Tract Boundaries within Madison County (2012-2017)



Source: Census TIGER Line Tract boundary data for Madiscon County, 2015; Compiled List of Unique Roadblocks

84. Assuming that the roadblocks that occurred at one of these point locations along the border of adjoining census tracts could be assigned to any census tract within the 20 meter buffer distance, I used the ArcGIS Generate *Near Table Analysis* tool to identify all census tracts within 20 meters of each of these 82 roadblock points.

85. I joined the resultant *Near Analysis Output* table to the table of *Compiled Unique Roadblocks* by IN_FID, which is the identifier that links these two tables, to have more information about each roadblock point like *clean_address*. Similarly, I joined the census tract tabular data to the Near Analysis Table by NEAR_FID in order to add the census tract identifier (GEOID) for each census tract that was near the input roadblock point.

86. I exported the resulting table to a CSV file to further process it in R, a statistical programming software tool. I joined the tabular data in Exhibit 1 of Dr. Ricchetti's report to the *Near Analysis Output* table in order to have a value for *average black population percentage* for each census tract that was identified by the near analysis.

Using this expanded table, I calculated for each roadblock point the minimum and maximum black population percentages of the census tracts to which it could have been assigned – i.e., the census tracts it bordered.

87. I then identified the roadblock points that could have been but were not assigned to the tract with the maximum black population percentage. I repeated this process to identify the roadblock points that could have been but were not assigned to the tract with the minimum black population percentage. The results of this analysis are included in Appendix D.

88. The summary statistics for this table show that 327 roadblocks occurring at 36 different locations could have been assigned to census tracts with a higher black population percentage. The table also show that 216 roadblocks occurring at 44 different locations could have been assigned to census tracts with a lower black population percentage. In other words, there were more roadblocks that could have been assigned to tracts with a higher black population than roadblocks that could have been assigned to tracts with a lower black population.[59]

89. Contrary to what Mr. Funderburk suggests, this finding does not weaken or invalidate Dr. Ricchetti's analysis. Rather, this result suggests that Dr. Ricchetti's results are, if anything, more conservative than the true distribution.

[59] Four roadblock points (1, 101, 139, 234) that were the site of a total of 121 roadblocks were near a tract border that was also the border of Madison County and did not border another tract within Madison County. None of these roadblocks could have been assigned to any other tracts in Madison County. Two roadblock points (259, 321), the site of two roadblocks, were near the border of more than two tracts and could have been assigned to a tract with a higher or a lower percent black population.

4. CONCLUSION

90. I find that Dr. Ricchetti's geocoding was accurate, precise, and reliable. Dr. Ricchetti uses a highly regarded geocoding software, ArcGIS World Geocoding Service, to ensure high reliability in his geocoding output. Moreover, Dr. Ricchetti uses a standard metric of geocoding quality to evaluate positional accuracy and precision, the geocoding *match score*. He sets his match score threshold to 90 out of 100 to increase the level accuracy and precision in his geocoding output. Based on the academic literature, this is a relatively high match score cutoff.

91. Mr. Funderburk, on the other hand, claims that Dr. Ricchetti's geocoding was not accurate, precise, or reliable without offering clear definitions of what these terms mean or providing support for these claims. He implements no statistically sound or standard method of evaluating the accuracy, precision, or reliability of the geocoded locations. Mr. Funderburk attempts to use ground truthing to assess positional accuracy but his implementation of the method is not based on best practices. He fails to meet the professional standard of using a randomized sample in his analysis. Thus, any conclusions he draws about positional accuracy cannot be generalized to a statement about the geocoding quality of the data set as a whole.

92. Mr. Funderburk's claim that street intersections cannot be geocoded accurately is simply not supported by my experience or the research literature. As detailed above, the research literature on geocoding does not provide benchmarks for acceptable levels of geocoding positional accuracy and precision. Rather, the literature notes that acceptable levels for these characteristics are dependent on how the results of geocoding will be used.[60] Mr. Funderburk does not consider the positional accuracy that would be needed to locate a point in a street intersection within a census tract, which is how the geocoded points are used in Dr. Ricchetti's analysis. Setting aside the issue of roadblocks on census tract boundaries, for the purposes of counting roadblocks within a census tract, a location geocoded to any point within a street intersection is perfectly sufficient. Thus, for the vast majority of roadblock locations in Dr. Ricchetti's analysis that were not on the boundary of census tracts, identifying a census tract is very straightforward.

93. Similarly, Mr. Funderburk alleges that the coordinate reference system may be driving several of Dr. Ricchetti's alleged "errors", but this claim is simply

[60] Zandbergen, Paul A., "Geocoding Quality and Implications for Spatial Analysis," *Geography Compass*, 3(2), 2009, pp. 647–680.

implausible given how the small the magnitude of such differences would be given the application at hand.

94. While Mr. Funderburk notes that 82 roadblock locations are located on streets that are census tract boundaries, and thus could be said to straddle multiple census tracts, it is notable that Mr. Funderburk's analysis does not attempt to test how this could affect Dr. Ricchetti's analysis. He simply asserts that this type of measurement error "can have profound impacts on the number of roadblocks per census tract and is not a valid representation of what actually occurred," without offering any robustness test.[61] In my experience and in the research literature, there are standard ways to test whether the potential for error in a subset of data points will impact an analysis.[62]

95. For example, one could perform exercises in which the roadblocks are assigned to the least and most favorable census tracts relative to the analysis in question. Mr. Funderburk did not perform any such analysis. I, however, performed this analysis on the 82 roadblocks located on census tract boundaries. My results show that Dr. Ricchetti's analysis is more likely to assign roadblocks on census tract borders to the census tract with the relatively *lower share* of the population that is black. Thus, Dr. Ricchetti's geocoding of the boundary roadblocks does not systematically increase the count of roadblocks in census tracts with a relatively high black population percentage.

Executed on July 2, 2018.

Patricia Frontiera, Ph.D.

[61] Funderburk Report, ¶ 53.

[62] Strickland, Matthew J., et al, "Quantifying Geocode Location Error Using GIS Methods," *Environmental Health*, 6(10), 2007.

Appendix A

PATRICIA FRONTIERA
SOCIAL SCIENCES DATA LAB (D-LAB)
University of California, Berkeley
pfrontiera@berkeley.edu

EDUCATION

PH.D	University of California, Berkeley, California. Environmental Planning. 2005. Emphasis on geographic informational retrieval. Dissertation chair: John Radke.
M.L.I.S.	University of California, Berkeley, California. Library & Information Studies. 1992.
B.A.	Wellesley College, Wellesley, Massachusetts. History. 1984

RECENT PROFESSIONAL POSITIONS

2017 - present — **Geospatial Data Scientist, Social Sciences Data Lab (D-Lab), UC Berkeley**
Lead, advise, participate in and collaborate on research projections with a geographic data, mapping and or visualization component. Provide consulting and instructional services to the UC Berkeley community on related topics.

2014 – 2017 — **Academic Coordinator, Social Sciences Data Lab, UC Berkeley**
With a team of dedicated and talented colleagues, planned, developed, delivered and coordinated an instructional workshop program to support graduate-level data intensive social science research. Topic lead for trainings related to geospatial data and analysis.

TEACHING EXPERIENCE

2015-17	University of CA, Berkeley, Lecturer, Data Science Education Program *Geospatial Data Exploration and Visualization (ESPM88x)*
2012	University of CA, Berkeley, Lecturer, City and Regional Planning *Introduction to GIS and City Planning (CP204C)*
2010	University of CA, Berkeley, Lecturer, Environmental Science & Policy Management *Introduction to Geographic Information Systems (ESPM 72)*
2005	University of CA, Berkeley, Lecturer, Landscape Architecture *Quantitative Methods in Environmental Planning (LA221)*

PREVIOUS PROFESSIONAL POSITIONS

2008 - 2014 **Senior GIS Technology Specialist**, The San Francisco Estuary Institute

- Research on and development of custom web mapping applications and spatial analysis tools for exploring data and sharing information with a diverse group of stakeholders including scientists, planners, resource managers and the general public.

2005 - 2006 **Post-doctoral Researcher**, College of Natural Resources, UC Berkeley

- Researched structure vulnerability to wildfire in the wildland-urban interface. This work served as the basis of the wildfire risk and hazard assessment toolkit developed by the Center for Fire Research and Outreach.

1996 - 2003 **GIS Project Manager, Programmer/Analyst III**
Geographic Information Science Center, UC Berkeley, 2003

- Managed all aspects of GIS projects, including preparing work plans and budgets, supervising student employees, advising on and troubleshooting technical issues, and interacting with current and prospective clients as well as with related campus groups.

Center for Environmental Design Research, UC Berkeley, 1996-2002

- As a member of the research group REGIS (Research Program in Environmental Planning and Geographic Information Systems), pioneered the development and use of open standards and technologies for web-based access to geographic information for natural resource management and environment planning applications

1993 – 1996 **Computer Lab Manger,** City and Regional Planning / Landscape Architecture and Environmental Planning, UC Berkeley
Managed hardware and software resources for two departmental computer labs. This included a local area network of 50+ MS Windows-based and Mac computers, UNIX workstations, printers, plotters, scanners, and digitizers.

1990-1991 **Circulation Supervisor**, Main Library, UC Berkeley,

- Hired, trained, and supervised two full-time and 20+ part-time student library employees.

PUBLICATIONS AND PRESENTATIONS

- Frontiera, P. (2018 June). Tools and Techniques for Interactive Data Visualizations. Presented at the Berkeley Interdisciplinary Migration Institute Summer Workshop in Migration Research Methods.
- Frontiera, P. (2017, March). *Geospatial Data and the Louisiana Slave Conspiracies Project*. Presented at the Digital Humanities for Caribbean History Workshop, Harvard, MA.

- Frontiera, P. (2016, April). *Comparison of Reference Data used for Geocoding US Addresses.* Presented at the Annual Meeting of the Association of American Geographers, San Francisco, CA.
- Powell, S., von Vacano, C., and Frontiera, P. (2016, April). *Teaching the Geospatial for Digital Humanities.* Presented at the Association of American Geographers Annual Mtg, San Francisco, CA.
- Frontiera, P. (2013, April). *Developing a dynamic web-based landscape profile tool*. Presented at the 19th Annual California GIS Conference (CalGIS), Long Beach, CA.
- Frontiera, P. (2011, May). *Spatial methods for browsing and searching multi-media resource collections*. Invited speaker at the Plenary session of the Nevada GIS Annual Conference, organized by the National Archives and Records Administration, Reno, NV.
- Frontiera, P. (2010). Spatial data integration. In: B. Warf (Ed.) *Encyclopedia of Geography*, Thousand Oaks, CA: Sage.
- Frontiera, P. (2008). *Proceedings of the ACM 17th Conference on Information and Knowledge Management: Flamenco + Geo: extending a search interface based on hierarchical faceted metadata with geographic capabilities*. (GIR'08) Napa, Ca.
- Frontiera, P., Larson, R. & Radke, J. (2008). A comparison of geometric approaches to assessing spatial similarity for geographic information retrieval. *International Journal of Geographical Information Science*, 22:3, 337 - 360.
- Frontiera, P., & Foster, H. (2007, April). *Spatial approaches to representation and ranking for geographic information retrieval*. Presented at the Annual Meeting of the Association of American Geographers, San Francisco, CA.
- Moritz, M.A., Kelly, M., Kearns, F., Frontiera, P., Casey Cleve, C., Sapp, J., Waite, S. & Goldstein, N. (2006, March). *A webGIS decision-support tool for parcel-based fire hazard assessment in California*. Presented at the Annual Meeting of the Association of American Geographers, Chicago.
- Radke, J., Xu, J. & Frontiera, P. (2005, August). *Establishing concave geometric approximations to better capture spatial location, extent and shape for geographic information retrieval*. Presented at the 8th International Conference on GeoComputation (GeoComputation 2005), Ann Arbor, MI.
- Frontiera, P. (2004). *A probabilistic approach to spatial ranking for geographic information retrieval*. (Unpublished doctoral dissertation). University of California, Berkeley.
- Larson, R.R., & Frontiera, P. (2004, September). Spatial ranking methods for geographic information retrieval (GIR) in Digital Libraries. In Heery, R. & Lyon, L. (Eds), *Research and Advanced Technology for Digital Libraries: 8th European Conference on Digital Libraries* (ECDL'04), Bath, UK. *Springer LNCS* 3232: 45-56. (***This paper received the conference DELOS award for Best Paper).***
- Larson, R.R., & Frontiera, P. (2004, July). *Ranking and representation for geographic information retrieval*. Presented at SIGIR 2004 Workshop on Geographic Information Retrieval. Sheffield, UK.
- Landis, J., Reilly, M., Twiss, R., Foster, H., and Frontiera, P. (2001). Forecasting and mitigating future urban encroachment adjacent to CA military installations, *IURD Working Paper*, University of CA, Berkeley.
- Frontiera, P. (2001, March). *Spatial metadata and geographic knowledge discovery*. Presented at the 92nd Conference of the American Planning Association, New Orleans, LA.

Appendix B

Documents Considered by Patricia Frontiera, Ph.D.

Expert Report

Expert Report of Bryan Ricchetti, Ph D with associated exhibits, appendices, and production	March 13, 2018
Expert Report of William R Funderburk with associated exhibits, appendices, and production	May 8, 2018

Depositions

Deposition of Bryan Ricchetti, Ph D	April 6, 2018
Deposition of William R Funderburk	June 20, 2018

Academic Literature

Abe, Toshi, and David Stinchcomb, "Geocoding Practices in Cancer Registries," Gerard Rushton et al , (Eds), *Geocoding Health Data: The Use of Geographic Codes in Cancer Prevention and Control, Research and Practice* , CRC Press, Boca Raton, Florida, pp 111–125 — 2008

Bigham, John M , et al , "Geocoding Police Collision Report Data from California: A Comprehensive Approach," *International Journal of Health Geographics* , 8(72), pp 1–10 — 2009

Duncan, Dustin T , et al , "Evaluation of the Positional Difference Between Two Common Geocoding Methods," *Geospatial Health* , 5(2), pp 265–273 — 2011

Dutta, Arup, et al , "System for Digitizing Information on Wisconsin's Crash Locations," *Journal of the Transportation Research Board* , (19), pp 256–264 — 2007

Goldberg, Daniel W , "A Geocoding Best Practices Guide," *The North American Association of Central Cancer Registries* — 2008

Goldberg, Daniel W , John P Wilson, and Craig A Knoblock, "From Text to Geographic Coordinates: The Current State of Geocoding," *Journal of the Urban and Regional Information Systems Association* , 19(1), pp 33–46 — 2007

Krieger, Nancy, "A Century of Census Tracts: Health & the Body Politic (1906 –2006)," *Journal of Urban Health: Bulletin of the New York Academy of Medicine* , 83(3), pp 355–361 — 2006

Krieger, Nancy, et al , "Geocoding and Monitoring of US Socioeconomic Inequalities in Mortality and Cancer Incidence: Does the Choice of Area-based Measure and Geographic Level Matter?," *American Journal of Epidemiology* , 156(5), pp 471–482 — 2002

Levine, Ned, and Karl E Kim, "The Location of Motor Vehicle Crashes in Honolulu: A Methodology for Geocoding Intersections," *Computers, Environment and Urban Systems* , 22(6), pp 557–576 — 1998

Park, Shin Hyoung, et al , "Geocoding Vehicle Collisions on Korean Expressways Based on Postmile Referencing," *Journal of Civil Engineering* , 15(8), pp 1435-1441 — 2011

Qin, Xiao, et al , "Intelligent Geocoding System to Locate Traffic Crashes," *Accident Analysis and Prevention* , 50, pp 1034–1041 — 2013

Ratcliffe, Jerry H , "Geocoding Crime and a First Estimate of a Minimum Acceptable Hit Rate," *International Journal of Geographical Information Science* , 18(1), pp 61–72 — 2004

Roongpiboonsopit, Duangduen, and Hassan A Karimi, "Comparative Evaluation and Analysis of Online Geocoding Services," *International Journal of Geographical Informational Science* , 24(7), pp 1081–1100 — 2010

Schootman, Mario, et al , "Positional Accuracy and Geographic Bias of Four Methods of Geocoding in Epidemiologic Research," *Annals of Epidemiology* , 17(6), pp 464–470 — 2007

Spatial and Spatio-temporal Epidemiology , 3(2) — 2012

Strickland, Matthew J , et al, "Quantifying Geocode Location Error Using GIS Methods," *Environmental Health* , 6(10), pp 1–8 — 2007

Yang, Duck-Hye et al , "Improving Geocoding Practices: Evaluation of Geocoding Tools," *Journal of Medical Systems* , 28(4), pp 361–370 — 2004

Zandbergen, Paul A , "A Comparison of Address Point, Parcel and Street Geocoding Techniques," *Computers, Environment and Urban Systems* , 32(3), pp 214–232 — 2008

Zandbergen, Paul A , "Geocoding Quality and Implications for Spatial Analysis," *Geography Compass* , 3(2), pp 647–680 — 2009

Zhan, F B et al , "Match Rate and Positional Accuracy for Two Geocoding Methods for Epidemiologic Research," *Annals of Epidemiology* , 16(11), pp 842–849 — 2006

Documents Considered by Patricia Frontiera, Ph.D.

Public Press/Websites

2017 TIGER/Line Shapefiles Technical Documentation, available at *U.S. Census Bureau*, https://www2 census gov/geo/pdfs/maps-data/data/tiger/tgrshp2017/TGRSHP2017_TechDoc_Ch1 pdf

Fromhertz, Pamela, "Datums and Tools to Connect Geospatial Data Accurately," *National Oceanic and Atmospheric Administration*, available at https://www ngs noaa gov/web/science_edu/presentations_library/files/usgs_css_brownbag20june2012final p df — June 20, 2012

Mississippi Automated Resource Information System, http://www maris state ms us

Positional Accuracy of TIGER/Line Data, available at *U.S. Census Bureau*, https://www census gov/geo/landview/lv6help/pos_acc html

Service Output, available at *ArcGIS for Developers*, https://developers arcgis com/rest/geocode/api-reference/geocoding-service-output htm

The Public Health Disparities Geocoding Project, available at Harvard T H Chan School of Public Health, https://www hsph harvard edu/thegeocodingproject

Other

arcgis_geocoding py

Appendix C

Compiled Unique Roadblocks

Point ID *rid*	Longitude *lon*	Latitude *lat*	Clean Address *clean_address*	Original Address *original_address*	Census Tract ID *geoid*	Number of Roadblocks *num_rbs*
1	-90.17706°	32.40025°	W COUNTY LINE RD AND I-220, MADISON COUNTY, MS	W COUNTY LINE RD / I-220 RID	28089030206	114
2	-90.03243°	32.61859°	DOBSON AVE AND YANDELL AVE, MADISON COUNTY, MS	DOBSON AVE / YANDELL AVE CAN	28089030600	78
3	-90.08861°	32.41169°	LOWER SPILLWAY RD, MADISON COUNTY, MS	LOWER SPILLWAY RD RID	28089030107	65
4	-90.10804°	32.40255°	OLD CANTON RD AND PINE KNOLL DR, MADISON COUNTY, MS	OLD CANTON RD / PINE KNOLL DR RID	28089030106	59
5	-90.01619°	32.61733°	HARGON ST AND COVINGTON DR, MADISON COUNTY, MS	HARGON ST / COVINGTON DR CAN	28089030600	48
6	-90.08585°	32.42646°	POST RD AND RICE RD, MADISON COUNTY, MS	POST RD / RICE RD CAN	28089030107	44
7	-90.08901°	32.70230°	OLD YAZOO CITY RD AND HWY 16, MADISON COUNTY, MS	OLD YAZOO CITY RD / HWY 16 CAN	28089030400	39
8	-90.03373°	32.64035°	W HWY 16 AND GREEN ACRES, MADISON COUNTY, MS	W HWY 16 / GREEN ACRES CAN	28089030600	38
9	-90.02047°	32.64771°	HWY 51 AND MORGAN RD, MADISON COUNTY, MS	HWY 51 / MORGAN RD CAN	28089030900	36
10	-89.98419°	32.63394°	HWY 43 AND GOODLOE RD, MADISON COUNTY, MS	HWY 43 / GOODLOE RD CAN	28089030900	34
11	-90.03488°	32.64034°	GREEN ACRES AND RAILROAD ST, MADISON COUNTY, MS	GREEN ACRES / RAILROAD ST CAN	28089030500	32
12	-89.94762°	32.54045°	PIPELINE RD AND HWY 43, MADISON COUNTY, MS	PIPELINE RD / HWY 43 CAN	28089030900	30
13	-89.93628°	32.62943°	HWY 16 E AND SHARON RD, MADISON COUNTY, MS	HWY 16 E / SHARON RD CAN	28089030900	25
14	-89.97501°	32.52461°	HWY 43 AND NATCHEZ TRACE PKWY, MADISON COUNTY, MS	HWY 43 / NATCHEZ TRACE PKWY CAN	28089030201	25
15	-90.31688°	32.57612°	KEARNEY PARK RD AND MIDDLE RD, MADISON COUNTY, MS	KEARNEY PARK RD / MIDDLE RD FLO	28089030302	23
16	-89.99530°	32.58217°	HWY 43 AND RANKIN RD, MADISON COUNTY, MS	HWY 43 / RANKIN RD CAN	28089030900	23
17	-90.17293°	32.45587°	LAKE CASTLE RD AND RICHARDSON RD, MADISON COUNTY, MS	LAKE CASTLE RD / RICHARDSON RD CAN	28089030204	21
18	-90.09314°	32.41200°	HARBOR AND LAKE HARBOR, MADISON COUNTY, MS	HARBOR / LAKE HARBOR CAN	28089030107	20
19	-89.98714°	32.61306°	HWY 16 AND AVONDALE RD, MADISON COUNTY, MS	HWY 16 / AVONDALE RD CAN	28089030600	19
20	-90.10651°	32.40515°	OLD CANTON RD AND WILLIAM BLVD, MADISON COUNTY, MS	OLD CANTON RD / WILLIAM BLVD RID	28089030106	19
21	-90.04395°	32.58722°	HWY 51 AND CORRECTIONS DR, MADISON COUNTY, MS	HWY 51 / CORRECTIONS DR CAN	28089030400	19
22	-90.10635°	32.41099°	HARBOUR PT XING AND OLD CANTON, MADISON COUNTY, MS	HARBOUR PT XING / OLD CANTON RID	28089030106	18
23	-90.00993°	32.66200°	HWY 51 AND STUMP BRIDGE RD, MADISON COUNTY, MS	HWY 51 / STUMP BRIDGE RD CAN	28089030900	18
24	-90.34702°	32.58657°	LIVINGSTON VERNON RD AND HWY 49, MADISON COUNTY, MS	LIVINGSTON VERNON RD / HWY 49 CAN	28089030302	17
25	-90.13207°	32.40682°	TOWNE CENTER AND WHEATLEY, MADISON COUNTY, MS	TOWNE CENTER / WHEATLEY RID	28089030106	17
26	-90.03995°	32.61873°	RAILROAD ST AND GEORGE WASHINGTO, MADISON COUNTY, MS	RAILROAD ST / GEORGE WASHINGTO CAN	28089030500	16
27	-90.00690°	32.59394°	S HWY 43 AND CANTON PARKWAY, MADISON COUNTY, MS	S HWY 43 / CANTON PARKWAY CAN	28089030800	15
28	-90.05064°	32.61831°	386 RICKS DR, MADISON COUNTY, MS	386 RICKS DR CAN	28089030500	15
29	-90.21576°	32.55336°	HWY 463 AND HWY 22, MADISON COUNTY, MS	HWY 463 / HWY 22 CAN	28089030400	14
30	-90.05895°	32.60921°	W PEACE ST AND PLUMNER DR, MADISON COUNTY, MS	W PEACE ST / PLUMNER DR CAN	28089030500	14
31	-90.03978°	32.56027°	N OLD CANTON RD AND ENDRIS, MADISON COUNTY, MS	N OLD CANTON RD / ENDRIS CAN	28089030400	13
32	-90.03453°	32.62375°	N UNION ST AND MARTIN LUTHER KING, MADISON COUNTY, MS	N UNION ST / MARTIN LUTHER KING CAN	28089030600	13
33	-90.19194°	32.52423°	HWY 463 AND GLUCKSTADT RD, MADISON COUNTY, MS	HWY 463 / GLUCKSTADT RD MAD	28089030301	12
34	-89.75151°	32.76045°	HWY 43 AND CAUTHEN RD, MADISON COUNTY, MS	HWY 43 / CAUTHEN RD CAN	28089031000	12
35	-90.05486°	32.61625°	FOLEY AVE AND KING RANCH RD, MADISON COUNTY, MS	FOLEY AVE / KING RANCH RD CAN	28089030500	12
36	-90.04443°	32.61505°	MARTIN LUTHER KING DR AND N UNIO, MADISON COUNTY, MS	MARTIN LUTHER KING DR / N UNIO CAN	28089030500	11
37	-90.19989°	32.42081°	LIVINGSTON RD AND OLD AGENCY RD, MADISON COUNTY, MS	LIVINGSTON RD / OLD AGENCY RD CAN	28089030206	11
38	-90.08933°	32.60985°	VIRLILIA RD AND OLD YAZOO CITY R, MADISON COUNTY, MS	VIRLILIA RD / OLD YAZOO CITY R CAN	28089030400	11
39	-90.17659°	32.40026°	I-220 AND W COUNTY LINE RD, MADISON COUNTY, MS	I-220 / W COUNTY LINE RD CAN	28089030206	11
40	-89.96871°	32.64816°	HWY 51 AND HWY 17, MADISON COUNTY, MS	HWY 51 / HWY 17 CAN	28089031000	11
41	-89.94247°	32.71290°	SHARON RD AND STUMP BRIDGE RD, MADISON COUNTY, MS	SHARON RD / STUMP BRIDGE RD CAN	28089030900	11
42	-90.08634°	32.43253°	WRIGHTS MILL DR AND RICE RD, MADISON COUNTY, MS	WRIGHTS MILL DR / RICE RD MAD	28089030101	11
43	-90.18657°	32.45495°	N LIVINGSTON RD AND LAKE CASTLE RD, MADISON COUNTY, MS	N LIVINGSTON RD / LAKE CASTLE RD MAD	28089030302	10
44	-89.93623°	32.65844°	HWY 43 AND SHARON RD, MADISON COUNTY, MS	HWY 43 / SHARON RD CAN	28089030900	10
45	-90.27290°	32.49579°	ROBINSON SPRINGS RD AND POCAHONTAS, MADISON COUNTY, MS	ROBINSON SPRINGS RD / POCAHONTAS FLO	28089030302	10
46	-90.10394°	32.40173°	PINE KNOLL DR, MADISON COUNTY, MS	PINE KNOLL DR RID	28089030106	9
47	-90.04323°	32.62372°	619 MARTIN LUTHER KING DR, MADISON COUNTY, MS	619 MARTIN LUTHER KING DR CAN	28089030500	9

Compiled Unique Roadblocks

Point ID *rid*	Longitude *lon*	Latitude *lat*	Clean Address *clean_address*	Original Address *original_address*	Census Tract ID *geoid*	Number of Roadblocks *num_rbs*
48	-90.07125°	32.53918°	HWY 51 AND SOWELL RD, MADISON COUNTY, MS	HWY 51 / SOWELL RD CAN	28089030400	9
49	-89.97754°	32.52706°	HWY 43 AND YANDELL RD, MADISON COUNTY, MS	HWY 43 / YANDELL RD CAN	28089030201	9
50	-90.24606°	32.56062°	LIVINGSTON VERNON RD AND STOKES, MADISON COUNTY, MS	LIVINGSTON VERNON RD / STOKES CAN	28089030302	8
51	-89.99343°	32.51694°	YANDELL RD AND TWELVE OAKS TRACE, MADISON COUNTY, MS	YANDELL RD / TWELVE OAKS TRACE CAN	28089030201	8
52	-90.06342°	32.46510°	HOY RD AND OLD RICE RD, MADISON COUNTY, MS	HOY RD / OLD RICE RD MAD	28089030201	8
53	-90.08884°	32.41167°	SPILLWAY RD AND BREAKERS LN, MADISON COUNTY, MS	SPILLWAY RD / BREAKERS LN RID	28089030108	8
54	-90.04675°	32.61854°	BOYD ST AND GEORGE WASHINGTON AV, MADISON COUNTY, MS	BOYD ST / GEORGE WASHINGTON AV CAN	28089030500	8
55	-90.03732°	32.62369°	JAMES ST AND MARTIN LUTHER KING, MADISON COUNTY, MS	JAMES ST / MARTIN LUTHER KING CAN	28089030600	8
56	-90.00256°	32.69114°	HWY 51 AND DAVIS CROSSING, MADISON COUNTY, MS	HWY 51 / DAVIS CROSSING CAN	28089030900	7
57	-90.13654°	32.58305°	HWY 22 AND CATLETT RD, MADISON COUNTY, MS	HWY 22 / CATLETT RD CAN	28089030400	7
58	-89.99523°	32.56037°	HWY 43 AND ENDRIS RD, MADISON COUNTY, MS	HWY 43 / ENDRIS RD CAN	28089030900	7
59	-90.14375°	32.42818°	NATCHEZ TRACE PKWY AND I-55, MADISON COUNTY, MS	NATCHEZ TRACE PKWY / I-55 RID	28089030105	7
60	-90.05764°	32.47233°	OLD RICE RD AND SHADOW HILL DR, MADISON COUNTY, MS	OLD RICE RD / SHADOW HILL DR CAN	28089030201	7
61	-90.03606°	32.51933°	OLD CANTON RD AND YANDELL RD, MADISON COUNTY, MS	OLD CANTON RD / YANDELL RD CAN	28089030400	7
62	-90.04661°	32.58060°	HWY 51 AND NISSAN PKWY, MADISON COUNTY, MS	HWY 51 / NISSAN PKWY CAN	28089030400	7
63	-90.17767°	32.53667°	124 N I-55, MADISON COUNTY, MS	124 N I-55 CAN	28089030400	7
64	-90.20086°	32.44432°	LAKE CAVALIER RD AND N LIVINGSTO, MADISON COUNTY, MS	LAKE CAVALIER RD / N LIVINGSTO MAD	28089030302	7
65	-90.30367°	32.51155°	HWY 49 AND PETRIFIED FOREST RD, MADISON COUNTY, MS	HWY 49 / PETRIFIED FOREST RD CAN	28089030302	6
66	-90.08624°	32.43537°	BREEZY HILL DR AND RICE RD, MADISON COUNTY, MS	BREEZY HILL DR / RICE RD MAD	28089030101	6
67	-90.12352°	32.42500°	RICE RD AND PEAR ORCHARD RD, MADISON COUNTY, MS	RICE RD / PEAR ORCHARD RD RID	28089030104	6
68	-90.10031°	32.40473°	WILLIAM BLVD, MADISON COUNTY, MS	WILLIAM BLVD CAN	28089030108	6
69	-90.04659°	32.62272°	HOLMES AVE AND MACE ST, MADISON COUNTY, MS	HOLMES AVE / MACE ST CAN	28089030500	6
70	-90.33251°	32.57189°	HWY 49 AND MIDDLE RD, MADISON COUNTY, MS	HWY 49 / MIDDLE RD CAN	28089030302	6
71	-89.99081°	32.74889°	HWY 51 AND WAY RD, MADISON COUNTY, MS	HWY 51 / WAY RD CAN	28089031000	6
72	-90.03845°	32.62370°	RAILROAD ST AND MARTIN LUTHER KI, MADISON COUNTY, MS	RAILROAD ST / MARTIN LUTHER KI CAN	28089030500	6
73	-90.03853°	32.62370°	MARTIN LUTHER KING DR AND RAILRO, MADISON COUNTY, MS	MARTIN LUTHER KING DR / RAILRO CAN	28089030500	6
74	-90.03064°	32.62256°	RICHARD CIR, MADISON COUNTY, MS	RICHARD CIR CAN	28089030600	5
75	-89.87284°	32.69706°	HWY 43 AND SULPHUR SPRINGS RD, MADISON COUNTY, MS	HWY 43 / SULPHUR SPRINGS RD CAN	28089030900	5
76	-90.13625°	32.55328°	STOUT RD AND CATLETT RD, MADISON COUNTY, MS	STOUT RD / CATLETT RD CAN	28089030400	5
77	-90.10902°	32.41405°	LAKE HARBOUR DRIVE AND RANKIN, MADISON COUNTY, MS	Lake Harbour Drive / Rankin	28089030104	5
78	-90.08939°	32.59407°	OLD JACKSON RD AND HWY 22, MADISON COUNTY, MS	OLD JACKSON RD / HWY 22 CAN	28089030400	5
79	-90.02678°	32.63860°	RR AND GREEN ACRES, MADISON COUNTY, MS	RR / GREEN ACRES CAN	28089030600	5
80	-90.15769°	32.51791°	GLUCKSTADT RD AND DEWEES RD, MADISON COUNTY, MS	GLUCKSTADT RD / DEWEES RD CAN	28089030301	5
81	-90.09998°	32.58411°	HWY 22 AND CALHOUN PKWY, MADISON COUNTY, MS	HWY 22 / CALHOUN PKWY CAN	28089030400	5
82	-90.04471°	32.58624°	2935 HWY 51, MADISON COUNTY, MS	2935 HWY 51 CAN	28089030400	5
83	-90.17540°	32.42945°	122 NATCHEZ TRACE PKWY, MADISON COUNTY, MS	122 NATCHEZ TRACE PKWY CAN	28089030205	5
84	-89.90604°	32.63900°	HWY 16 AND RATLIFF FERRY RD, MADISON COUNTY, MS	HWY 16 / RATLIFF FERRY RD CAN	28089030900	5
85	-89.80946°	32.71561°	HWY 17 AND SULPHUR SPRINGS RD, MADISON COUNTY, MS	HWY 17 / SULPHUR SPRINGS RD CAN	28089031000	5
86	-90.36656°	32.49876°	HWY 22 AND SPRING CREEK RD, MADISON COUNTY, MS	HWY 22 / SPRING CREEK RD CAN	28089030302	5
87	-90.04675°	32.61502°	BOYD ST AND WEST NORTH, MADISON COUNTY, MS	BOYD ST / WEST NORTH CAN	28089030500	5
88	-90.30414°	32.54594°	HWY 22 AND BANNERMAN DR, MADISON COUNTY, MS	HWY 22 / BANNERMAN DR FLO	28089030302	5
89	-90.13200°	32.51692°	GLUCKSTADT RD AND CATLETT RD, MADISON COUNTY, MS	GLUCKSTADT RD / CATLETT RD CAN	28089030400	4
90	-90.09339°	32.58894°	NISSAN PKWY AND HWY 22, MADISON COUNTY, MS	NISSAN PKWY / HWY 22 CAN	28089030400	4
91	-90.04230°	32.61015°	CANAL ST AND W ACADEMY ST, MADISON COUNTY, MS	CANAL ST / W ACADEMY ST CAN	28089030500	4
92	-90.08905°	32.54971°	OLD JACKSON RD AND I-55, MADISON COUNTY, MS	OLD JACKSON RD / I-55 MAD	28089030400	4
93	-90.03763°	32.62758°	RAILROAD ST, MADISON COUNTY, MS	RAILROAD ST CAN	28089030500	4
94	-90.04050°	32.49149°	N OLD CANTON RD AND DAVE BROWN RD, MADISON COUNTY, MS	N OLD CANTON RD / DAVE BROWN RD CAN	28089030201	4

Compiled Unique Roadblocks

Point ID *rid*	Longitude *lon*	Latitude *lat*	Clean Address *clean_address*	Original Address *original_address*	Census Tract ID *geoid*	Number of Roadblocks *num_rbs*
95	-89.83875°	32.78221°	LORING RD AND HWY 17, MADISON COUNTY, MS	LORING RD / HWY 17 CAN	28089031000	4
96	-90.04422°	32.62127°	MLK AND ADELINE ST, MADISON COUNTY, MS	MLK / ADELINE ST CAN	28089030500	4
97	-89.82129°	32.74313°	HWY 17 AND HWY 43, MADISON COUNTY, MS	HWY 17 / HWY 43 CAN	28089031000	4
98	-90.07178°	32.51710°	YANDELL RD AND CLARKDELL RD, MADISON COUNTY, MS	YANDELL RD / CLARKDELL RD CAN	28089030400	4
99	-90.30883°	32.54264°	RAILROAD AV AND CMU, MADISON COUNTY, MS	RAILROAD AV / CMU CAN	28089030302	4
100	-90.07054°	32.51711°	YANDELL RD AND MADISON CROSSING, MADISON COUNTY, MS	YANDELL RD / MADISON CROSSING MAD	28089030400	4
101	-90.16200°	32.40020°	W COUNTY LINE AND HIGHLAND COLONY, MADISON COUNTY, MS	W COUNTY LINE / HIGHLAND COLONY CAN	28089030206	4
102	-90.04027°	32.61506°	RAILROAD ST AND W NORTH ST, MADISON COUNTY, MS	RAILROAD ST / W NORTH ST CAN	28089030500	4
103	-90.04423°	32.61856°	GEORGE WASHINGTON AVE AND KING R, MADISON COUNTY, MS	GEORGE WASHINGTON AVE / KING R CAN	28089030500	4
104	-90.03175°	32.62266°	RICHARD CIR AND DOBSON AVE, MADISON COUNTY, MS	RICHARD CIR / DOBSON AVE CAN	28089030600	4
105	-89.98656°	32.77806°	HWY 51 AND LORING RD, MADISON COUNTY, MS	HWY 51 / LORING RD CAN	28089031000	4
106	-90.03940°	32.61135°	CAMERON ST AND W FULTON ST, MADISON COUNTY, MS	CAMERON ST / W FULTON ST CAN	28089030700	4
107	-89.76596°	32.74020°	SULPHUR SPRING RD AND GIN RD, MADISON COUNTY, MS	SULPHUR SPRING RD / GIN RD CAN	28089030900	4
108	-90.09547°	32.49241°	HWY 51 AND GREEN OAK LN, MADISON COUNTY, MS	HWY 51 / GREEN OAK LN CAN	28089030204	4
109	-90.10649°	32.44727°	OLD CANTON RD AND CALUMET DR, MADISON COUNTY, MS	OLD CANTON RD / CALUMET DR CAN	28089030101	4
110	-90.10625°	32.41099°	HARBOUR POINTE CROSSING AND NORT, MADISON COUNTY, MS	HARBOUR POINTE CROSSING / NORT RID	28089030108	4
111	-90.26584°	32.55144°	HWY 22 AND ANDOVER DR, MADISON COUNTY, MS	HWY 22 / ANDOVER DR CAN	28089030302	4
112	-90.28812°	32.58969°	LIVINGSTON VERNON RD AND ST CHAR, MADISON COUNTY, MS	LIVINGSTON VERNON RD / ST CHAR FLO	28089030302	3
113	-90.09117°	32.46505°	HOY RD AND RICE RD, MADISON COUNTY, MS	HOY RD / RICE RD MAD	28089030202	3
114	-90.16108°	32.44203°	STEED RD AND RICHARDSON RD, MADISON COUNTY, MS	STEED RD / RICHARDSON RD CAN	28089030205	3
115	-90.01183°	32.63320°	FINNEY RD AND MORGAN RD, MADISON COUNTY, MS	FINNEY RD / MORGAN RD CAN	28089030600	3
116	-89.93620°	32.61851°	ROBINSON RD AND SHARON RD, MADISON COUNTY, MS	ROBINSON RD / SHARON RD CAN	28089030900	3
117	-90.18071°	32.49437°	REUNION PKWY AND HWY 463, MADISON COUNTY, MS	REUNION PKWY / HWY 463 MAD	28089030301	3
118	-90.20074°	32.48393°	ROBINSON SPRINGS RD AND POC, MADISON COUNTY, MS	ROBINSON SPRINGS RD / POC CAN	28089030302	3
119	-90.03204°	32.63382°	1415 W HWY 16, MADISON COUNTY, MS	1415 W HWY 16 CAN	28089030600	3
120	-90.19274°	32.53379°	HWY 463 AND STRIBLING RD, MADISON COUNTY, MS	HWY 463 / STRIBLING RD MAD	28089030400	3
121	-90.02982°	32.63197°	W HWY 16 AND HWY 51, MADISON COUNTY, MS	W HWY 16 / HWY 51 CAN	28089030600	3
122	-90.10952°	32.46509°	HWY 463 AND MADISON MIDDLE, MADISON COUNTY, MS	HWY 463 / MADISON MIDDLE CAN	28089030203	3
123	-90.04636°	32.62125°	ADELINE ST AND SINGLETON ST, MADISON COUNTY, MS	ADELINE ST / SINGLETON ST CAN	28089030500	3
124	-89.96964°	32.52200°	HWY 43 AND TURCOTTE LAB DR, MADISON COUNTY, MS	HWY 43 / TURCOTTE LAB DR CAN	28089030900	3
125	-89.76804°	32.75790°	HWY 43 AND GIN RD, MADISON COUNTY, MS	HWY 43 / GIN RD CAR	28089031000	3
126	-90.04845°	32.58081°	HWY 51 AND HWY 16 W, MADISON COUNTY, MS	HWY 51 / HWY 16 W CAN	28089030400	3
127	-90.07056°	32.51712°	300 YANDELL RD, MADISON COUNTY, MS	300 YANDELL RD CAN	28089030400	3
128	-90.03489°	32.61564°	HWY 16 AND HWY 51, MADISON COUNTY, MS	HWY 16 / HWY 51 CAN	28089030600	3
129	-90.05051°	32.54239°	SMITH CARR AND E SOWELL RD, MADISON COUNTY, MS	SMITH CARR / E SOWELL RD CAN	28089030400	3
130	-90.28852°	32.51952°	POCAHONTAS RD AND MT LEOPARD RD, MADISON COUNTY, MS	POCAHONTAS RD / MT LEOPARD RD FLO	28089030302	3
131	-90.04586°	32.61856°	GEORGE WASHINGTON AVE AND RR, MADISON COUNTY, MS	GEORGE WASHINGTON AVE / RR CAN	28089030500	3
132	-90.02171°	32.62303°	INDUSTRIAL DR AND MATTHEWS AVE, MADISON COUNTY, MS	INDUSTRIAL DR / MATTHEWS AVE CAN	28089030600	3
133	-90.18177°	32.40091°	HIGHLAND COLONY PKWY, MADISON COUNTY, MS	HIGHLAND COLONY PKWY MAD	28089030206	3
134	-90.05479°	32.62358°	HOLMES AVE AND KING RANCH RD, MADISON COUNTY, MS	HOLMES AVE / KING RANCH RD CAN	28089030500	3
135	-90.31086°	32.58966°	LIVINGSTON VERNON RD AND HARRIS, MADISON COUNTY, MS	LIVINGSTON VERNON RD / HARRIS FLO	28089030302	3
136	-90.03756°	32.69114°	WAY RD AND DAVIS CROSSING RD, MADISON COUNTY, MS	WAY RD / DAVIS CROSSING RD CAN	28089030400	3
137	-90.02915°	32.62176°	WILSON ST AND RICHARD CIR, MADISON COUNTY, MS	WILSON ST / RICHARD CIR CAN	28089030600	3
138	-89.83578°	32.66105°	HWY 16 EAST AND PAT LUCKETT RD, MADISON COUNTY, MS	HWY 16 EAST / PAT LUCKETT RD CAN	28089030900	2
139	-90.20283°	32.40014°	N LIVINGSTON RD AND COUNTY LINE, MADISON COUNTY, MS	N LIVINGSTON RD / COUNTY LINE CAN	28089030206	2
140	-89.74710°	32.67308°	WALNUT RD AND NATCHEZ TRACE PKWY, MADISON COUNTY, MS	WALNUT RD / NATCHEZ TRACE PKWY CAN	28089030900	2
141	-90.12998°	32.42631°	HWY 51 AND NATCHEZ TRACE, MADISON COUNTY, MS	HWY 51 / NATCHEZ TRACE RID	28089030101	2

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142	-90.05891°	32.87738°	N HWY 55 AND 124, MADISON COUNTY, MS	N HWY 55 / 124 CAN	28089030400	2
143	-90.06363°	32.58545°	NISSAN PKWY AND NISSAN DR, MADISON COUNTY, MS	NISSAN PKWY / NISSAN DR CAN	28089030400	2
144	-90.03809°	32.52589°	OLD CANTON RD AND HARVEY CROSSIN, MADISON COUNTY, MS	OLD CANTON RD / HARVEY CROSSIN CAN	28089030400	2
145	-89.87010°	32.69686°	SULPHUR SPRINGS RD AND POTLUCK R, MADISON COUNTY, MS	SULPHUR SPRINGS RD / POTLUCK R CAN	28089030900	2
146	-90.04002°	32.61634°	RAILROAD ST AND BOWMAN ST, MADISON COUNTY, MS	RAILROAD ST / BOWMAN ST CAN	28089030500	2
147	-89.99324°	32.53900°	HWY 43 AND COTTON BLOSSOM RD, MADISON COUNTY, MS	HWY 43 / COTTON BLOSSOM RD CAN	28089030900	2
148	-89.85848°	32.60366°	RATLIFF FERRY RD AND BOYD DR, MADISON COUNTY, MS	RATLIFF FERRY RD / BOYD DR CAN	28089030800	2
149	-90.04962°	32.62435°	707 MACE ST, MADISON COUNTY, MS	707 MACE ST CAN	28089030500	2
150	-90.07275°	32.48760°	CLARKDELL RD AND GREEN OAK LN, MADISON COUNTY, MS	CLARKDELL RD / GREEN OAK LN CAN	28089030201	2
151	-90.07205°	32.51708°	YANDELL RD AND BRACEY RD, MADISON COUNTY, MS	YANDELL RD / BRACEY RD CAN	28089030400	2
152	-90.08808°	32.54776°	NISSAN DR AND OLD JACKSON RD, MADISON COUNTY, MS	NISSAN DR / OLD JACKSON RD CAN	28089030400	2
153	-90.05885°	32.56297°	HWY 51 AND LINKS DR, MADISON COUNTY, MS	HWY 51 / LINKS DR CAN	28089030400	2
154	-90.19946°	32.42228°	N LIVINGSTON RD AND NATCHEZ TRACE BRIDGE, MADISON COUNTY, MS	N LIVINGSTON RD / NATCHEZ TRACE BRIDGE MAD	28089030206	2
155	-90.17494°	32.56565°	MCMILLON RD AND HWY 22, MADISON COUNTY, MS	MCMILLON RD / HWY 22 MAD	28089030400	2
156	-90.07837°	32.54092°	SOWELL RD AND SOWELL RD, MADISON COUNTY, MS	SOWELL RD / SOWELL RD MAD	28089030400	2
157	-89.96033°	32.62167°	E HWY 16 AND ROYAL OAK RD, MADISON COUNTY, MS	E HWY 16 / ROYAL OAK RD CAN	28089030600	2
158	-90.02995°	32.61016°	ACADEMY ST AND LYON ST, MADISON COUNTY, MS	ACADEMY ST / LYON ST CAN	28089030800	2
159	-90.09471°	32.41666°	HARBOR DR, MADISON COUNTY, MS	HARBOR DR CAN	28089030107	2
160	-90.22270°	32.43443°	GREENS CROSSING RD, MADISON COUNTY, MS	GREENS CROSSING RD MAD	28089030302	2
161	-90.07616°	32.51581°	YANDELL RD AND CLARKDELL RD EXT, MADISON COUNTY, MS	YANDELL RD / CLARKDELL RD EXT CAN	28089030400	2
162	-90.03642°	32.60406°	UNION ST AND W DINKINS ST, MADISON COUNTY, MS	UNION ST / W DINKINS ST CAN	28089030700	2
163	-90.33125°	32.53838°	HWY 22 AND CHILDRESS LN, MADISON COUNTY, MS	HWY 22 / CHILDRESS LN CAN	28089030302	2
164	-90.22630°	32.47419°	COKER RD AND LAKE CAVALIER RD, MADISON COUNTY, MS	COKER RD / LAKE CAVALIER RD MAD	28089030302	2
165	-89.98380°	32.79604°	HWY 51 AND 2 J'S, MADISON COUNTY, MS	HWY 51 / 2 J'S CAN	28089031000	2
166	-90.03491°	32.60404°	S LIBERTY ST AND W DINKINS ST, MADISON COUNTY, MS	S LIBERTY ST / W DINKINS ST CAN	28089030700	2
167	-90.05891°	32.68186°	W HWY 16 AND I-55, MADISON COUNTY, MS	W HWY 16 / I-55 CAN	28089030400	2
168	-90.05088°	32.60635°	WESTSIDE DR AND ROSEBUD DR, MADISON COUNTY, MS	WESTSIDE DR / ROSEBUD DR CAN	28089030500	2
169	-90.08910°	32.55703°	OLD JACKSON RD AND STOUT RD, MADISON COUNTY, MS	OLD JACKSON RD / STOUT RD CAN	28089030400	2
170	-90.05154°	32.62369°	1106 HOLMES AV, MADISON COUNTY, MS	1106 HOLMES AV CAN	28089030500	2
171	-89.90176°	32.62046°	RATLIFF FERRY RD AND ROBINSON RD, MADISON COUNTY, MS	RATLIFF FERRY RD / ROBINSON RD CAN	28089030900	2
172	-90.08939°	32.53932°	W SOWELL RD AND OLD JACKSON RD, MADISON COUNTY, MS	W SOWELL RD / OLD JACKSON RD CAN	28089030400	2
173	-90.09277°	32.42121°	831 RICE RD, MADISON COUNTY, MS	831 RICE RD RID	28089030107	2
174	-90.03481°	32.61856°	YANDELL AVE AND N LIBERTY ST, MADISON COUNTY, MS	YANDELL AVE / N LIBERTY ST CAN	28089030600	2
175	-90.02471°	32.62009°	INDUSTRIAL DR AND LINCOLN ST, MADISON COUNTY, MS	INDUSTRIAL DR / LINCOLN ST CAN	28089030600	2
176	-90.08908°	32.64043°	HEINDL RD AND OLD YAZOO CITY RD, MADISON COUNTY, MS	HEINDL RD / OLD YAZOO CITY RD CAN	28089030400	2
177	-90.13915°	32.49762°	BOZEMAN RD AND REUNION ANNANDALE, MADISON COUNTY, MS	BOZEMAN RD / REUNION ANNANDALE CAN	28089030301	2
178	-90.04214°	32.61342°	N CANAL ST AND FRANKLIN ST, MADISON COUNTY, MS	N CANAL ST / FRANKLIN ST CAN	28089030500	2
179	-90.00771°	32.60390°	HWY 43 AND DINKINS ST, MADISON COUNTY, MS	HWY 43 / DINKINS ST CAN	28089030800	2
180	-90.05140°	32.62360°	HOLMES AV, MADISON COUNTY, MS	HOLMES AV CAN	28089030500	2
181	-90.05552°	32.62804°	DORIS FRANCIS BLVD AND HARRINGTO, MADISON COUNTY, MS	DORIS FRANCIS BLVD / HARRINGTO CAN	28089030500	2
182	-90.02713°	32.61855°	LINCOLN ST AND YANDELL AVE, MADISON COUNTY, MS	LINCOLN ST / YANDELL AVE CAN	28089030600	2
183	-90.15706°	32.47879°	HWY 463 AND MANNSDALE, MADISON COUNTY, MS	HWY 463 / MANNSDALE CAN	28089030204	2
184	-90.08881°	32.58500°	NISSAN PKWY AND OLD JACKSON RD, MADISON COUNTY, MS	NISSAN PKWY / OLD JACKSON RD CAN	28089030400	2
185	-90.39897°	32.54276°	COX FERRY RD AND PHILLIPS RD, MADISON COUNTY, MS	COX FERRY RD / PHILLIPS RD CAN	28089030302	1
186	-90.06363°	32.58545°	NISSAN DR AND NISSAN PKWY, MADISON COUNTY, MS	NISSAN DR / NISSAN PKWY CAN	28089030400	1
187	-90.09473°	32.54018°	SOWELL RD AND I-55, MADISON COUNTY, MS	SOWELL RD / I-55 MAD	28089030400	1
188	-90.10644°	32.45044°	OLD CANTON RD AND ST AUGUSTINE D, MADISON COUNTY, MS	OLD CANTON RD / ST AUGUSTINE D MAD	28089030101	1

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189	-90.19880°	32.43164°	N LIVINGSTON RD AND COU, MADISON COUNTY, MS	N LIVINGSTON RD / COU CAN	28089030302	1
190	-90 08907°	32.57500°	OLD JACKSON RD AND BEAL RD, MADISON COUNTY, MS	OLD JACKSON RD / BEAL RD CAN	28089030400	1
191	-90.10415°	32.50607°	PARKWAY EAST AND INDUSTRIAL DR S, MADISON COUNTY, MS	PARKWAY EAST / INDUSTRIAL DR S MAD	28089030204	1
192	-89 85936°	32.65295°	E HWY 16 AND HOGUE RD, MADISON COUNTY, MS	E HWY 16 / HOGUE RD CAN	28089030900	1
193	-90 07460°	32.51260°	CLARKDELL RD EXT AND YAN, MADISON COUNTY, MS	CLARKDELL RD EXT / YAN CAN	28089030201	1
194	-90.11701°	32.45051°	HWY 51 AND ST AUGUSTINE DR, MADISON COUNTY, MS	HWY 51 / ST AUGUSTINE DR MAD	28089030101	1
195	-90 07709°	32.54250°	W SOWELL RD AND RR TRACKS, MADISON COUNTY, MS	W SOWELL RD / RR TRACKS MAD	28089030400	1
196	-90.16147°	32.51903°	463 AND GLUCKSTADT RD, MADISON COUNTY, MS	463 / GLUCKSTADT RD CAN	28089030301	1
197	-90 05438°	32.61625°	FOLEY AVE AND SUNSET AVE, MADISON COUNTY, MS	FOLEY AVE / SUNSET AVE CAN	28089030500	1
198	-90 03641°	32.60582°	S UNION ST AND CAR WASH, MADISON COUNTY, MS	S UNION ST / CAR WASH CAN	28089030700	1
199	-90 05148°	32.56248°	147 LINKS DR, MADISON COUNTY, MS	147 LINKS DR CAN	28089030400	1
200	-89 84158°	32.62989°	MIGGINS RD AND ROBINSON RD, MADISON COUNTY, MS	MIGGINS RD / ROBINSON RD CAN	28089030900	1
201	-90 03671°	32.64455°	130 JOHNSON HILL RD, MADISON COUNTY, MS	130 Johnson Hill Rd	28089030400	1
202	-90 30957°	32.54312°	KEARNEY PARK RD AND HWY 22, MADISON COUNTY, MS	KEARNEY PARK RD / HWY 22 CAN	28089030302	1
203	-89 97251°	32.52276°	HWY 43 AND BROWNS LANDING RD, MADISON COUNTY, MS	HWY 43 / BROWNS LANDING RD CAN	28089030201	1
204	-90.14530°	32.40591°	HWY 51 HWY 17, MADISON COUNTY, MS	HWY 51 HWY 17 CAN	28089030105	1
205	-90.11557°	32.40315°	NORTHPARK DR AND AVERY BLVD, MADISON COUNTY, MS	NORTHPARK DR / AVERY BLVD RID	28089030106	1
206	-90 04945°	32.61853°	RR AND GEORGE WASHINGTON, MADISON COUNTY, MS	RR / GEORGE WASHINGTON CAN	28089030500	1
207	-89 98096°	32.53080°	HWY 43 AND RAMAGE RD, MADISON COUNTY, MS	HWY 43 / RAMAGE RD CAN	28089030900	1
208	-90 02631°	32.60899°	ADAMS STREET AND PEAR STREET, MADISON COUNTY, MS	Adams Street / Pear Street	28089030600	1
209	-90 02434°	32.62009°	INDUSTRIAL DR AND MILLER ST, MADISON COUNTY, MS	INDUSTRIAL DR / MILLER ST CAN	28089030600	1
210	-90.14375°	32.54635°	CAROLINE BLVD AND BELLEVUE DR, MADISON COUNTY, MS	CAROLINE BLVD / BELLEVUE DR CAN	28089030400	1
211	-90 05476°	32.63267°	HEINDL RD AND KING RANCH RD, MADISON COUNTY, MS	HEINDL RD / KING RANCH RD CAN	28089030500	1
212	-90 05071°	32.61852°	GEORGE WASHINGTON AVE AND RICKS, MADISON COUNTY, MS	GEORGE WASHINGTON AVE / RICKS CAN	28089030500	1
213	-90 08624°	32.43536°	RICE AND WOODS CROSSING BLVD, MADISON COUNTY, MS	RICE / WOODS CROSSING BLVD CAN	28089030101	1
214	-90 04424°	32.61856°	MARTIN LUTHER KING DR AND GEORGE, MADISON COUNTY, MS	MARTIN LUTHER KING DR / GEORGE CAN	28089030500	1
215	-90.13109°	32.42473°	RICE RD AND HWY 51, MADISON COUNTY, MS	RICE RD / HWY 51 CAN	28089030105	1
216	-90.10944°	32.57921°	HWY 22 AND LAKESHIRE PKWY, MADISON COUNTY, MS	HWY 22 / LAKESHIRE PKWY CAN	28089030400	1
217	-90 05656°	32.61002°	PEACE ST AND FULTON ST, MADISON COUNTY, MS	PEACE ST / FULTON ST CAN	28089030500	1
218	-89 84984°	32.59728°	NATCHEZ TRACE AND RATLIFF FERRY, MADISON COUNTY, MS	NATCHEZ TRACE / RATLIFF FERRY CAN	28089030900	1
219	-90 03639°	32.61137°	UNION ST AND W FULTON ST, MADISON COUNTY, MS	UNION ST / W FULTON ST CAN	28089030700	1
220	-90 03140°	32.62366°	DOBSON AVE AND SHERWOOD DR, MADISON COUNTY, MS	DOBSON AVE / SHERWOOD DR CAN	28089030600	1
221	-90 04207°	32.61504°	CANAL ST AND W NORTH ST, MADISON COUNTY, MS	CANAL ST / W NORTH ST CAN	28089030500	1
222	-89 83123°	32.67559°	LOTTVILLE RD AND JOHN DAY RD, MADISON COUNTY, MS	LOTTVILLE RD / JOHN DAY RD CAN	28089030900	1
223	-90 04634°	32.60637°	CAUTHEN ST AND ROSEBUD DR, MADISON COUNTY, MS	CAUTHEN ST / ROSEBUD DR CAN	28089030500	1
224	-90 03604°	32.53884°	N OLD CANTON RD AND COTTON BLOSSOM, MADISON COUNTY, MS	N OLD CANTON RD / COTTON BLOSSOM CAN	28089030400	1
225	-90.15770°	32.53746°	STRIBLING RD AND DEWEES, MADISON COUNTY, MS	STRIBLING RD / DEWEES CAN	28089030400	1
226	-90 04530°	32.60691°	W OTTO ST AND COWAN ST, MADISON COUNTY, MS	W OTTO ST / COWAN ST CAN	28089030500	1
227	-90.12356°	32.41132°	PEAR ORCHARD ROAD AND PEAR ORCHARD CIRCLE, MADISON COUNTY, MS	Pear Orchard Road/Pear Orchard Circle	28089030106	1
228	-89.76431°	32.68560°	HWY 16 EAST AND VIRGIN MARY RD, MADISON COUNTY, MS	HWY 16 EAST / VIRGIN MARY RD CAN	28089030900	1
229	-90 31272°	32.53870°	FIRST ST AND ODOM ST, MADISON COUNTY, MS	FIRST ST / ODOM ST CAN	28089030302	1
230	-89 90139°	32.61053°	RATLIFF FERRY RD AND LONE PINE R, MADISON COUNTY, MS	RATLIFF FERRY RD / LONE PINE R CAN	28089030900	1
231	-90 31288°	32.54216°	FIRST ST AND MAIN ST, MADISON COUNTY, MS	FIRST ST / MAIN ST FLO	28089030302	1
232	-90 02425°	32.62274°	GARFIELD ST AND LINCOLN ST, MADISON COUNTY, MS	GARFIELD ST / LINCOLN ST CAN	28089030600	1
233	-90.14138°	32.51689°	GLUCKSTADT RD AND C STORE, MADISON COUNTY, MS	GLUCKSTADT RD / C STORE CAN	28089030301	1
234	-90.13148°	32.39951°	EAST COUNTY LINE ROAD AND MOSSLINE DRIVE, MADISON COUNTY, MS	East County Line Road / Mossline Drive	28089030106	1
235	-90 00818°	32.61122°	HWY 16 AND HWY 43, MADISON COUNTY, MS	HWY 16 / HWY 43 CAN	28089030600	1

Compiled Unique Roadblocks

Point ID *rid*	Longitude *lon*	Latitude *lat*	Clean Address *clean_address*	Original Address *original_address*	Census Tract ID *geoid*	Number of Roadblocks *num_rbs*
236	-90.06335°	32.46814°	OLD RICE RD AND ASPEN DR, MADISON COUNTY, MS	OLD RICE RD / ASPEN DR CAN	28089030201	1
237	-90.11382°	32.41400°	711 LAKE HARBOUR DR, MADISON COUNTY, MS	711 LAKE HARBOUR DR RID	28089030106	1
238	-90.10624°	32.53152°	STRIBLING EXT AND CHURCH, MADISON COUNTY, MS	STRIBLING EXT / CHURCH CAN	28089030400	1
239	-90.31713°	32.58966°	HUNT AVE AND LIVINGSTON VERNON R, MADISON COUNTY, MS	HUNT AVE / LIVINGSTON VERNON R FLO	28089030302	1
240	-89.96975°	32.61860°	E HWY 16 AND ROBINSON RD, MADISON COUNTY, MS	E HWY 16 / ROBINSON RD CAN	28089030900	1
241	-89.75100°	32.76061°	HWY 43 AND MATLOCK RD, MADISON COUNTY, MS	HWY 43 / MATLOCK RD CAN	28089031000	1
242	-89.81078°	32.64797°	ROBINSON RD AND PAT LUCKETT RD, MADISON COUNTY, MS	ROBINSON RD / PAT LUCKETT RD CAN	28089030900	1
243	-90.17900°	32.47503°	N LIVINGSTON RD AND MCDONALD DR, MADISON COUNTY, MS	N LIVINGSTON RD / MCDONALD DR CAN	28089030302	1
244	-90.10636°	32.41625°	OLD CANTON RD AND MRA, MADISON COUNTY, MS	OLD CANTON RD / MRA MAD	28089030104	1
245	-90.05216°	32.62362°	1101 HOLMES AV, MADISON COUNTY, MS	1101 HOLMES AV CAN	28089030500	1
246	-90.10262°	32.40516°	875 WILLIAM BLVD, MADISON COUNTY, MS	875 WILLIAM BLVD RID	28089030106	1
247	-90.20374°	32.40357°	N LIVINGSTON RD AND MARY MYLES RD, MADISON COUNTY, MS	N LIVINGSTON RD / MARY MYLES RD RID	28089030206	1
248	-90.10136°	32.51712°	N. I-55 AND GLUCKSTADT ROAD, MADISON COUNTY, MS	N. I-55/Gluckstadt Road	28089030400	1
249	-90.05374°	32.61559°	112 SUNSET AVE, MADISON COUNTY, MS	112 SUNSET AVE CAN	28089030500	1
250	-90.00686°	32.67412°	HWY 51 AND PISGAH BOTTOM RD, MADISON COUNTY, MS	HWY 51 / PISGAH BOTTOM RD CAN	28089030900	1
251	-90.12696°	32.52344°	STILLHOUSE CREEK DR, MADISON COUNTY, MS	STILLHOUSE CREEK DR CAN	28089030400	1
252	-90.29664°	32.53531°	POCAHONTAS RD AND JEFFREYS RD, MADISON COUNTY, MS	POCAHONTAS RD / JEFFREYS RD FLO	28089030302	1
253	-90.08908°	32.56078°	OLD JACKSON RD AND RAGSDALE RD, MADISON COUNTY, MS	OLD JACKSON RD / RAGSDALE RD MAD	28089030400	1
254	-89.90813°	32.65634°	OLD HWY 16 AND CHURCH LN, MADISON COUNTY, MS	OLD HWY 16 / CHURCH LN CAN	28089030900	1
255	-90.02883°	32.51694°	YANDELL RD AND DEERFIELD BLVD, MADISON COUNTY, MS	YANDELL RD / DEERFIELD BLVD CAN	28089030400	1
256	-89.81422°	32.65004°	HHY 43 AND HWY 17, MADISON COUNTY, MS	HHY 43 / HWY 17 CAN	28089030900	1
257	-90.14667°	32.40387°	HWY 51 AND I-55, MADISON COUNTY, MS	HWY 51 / I-55 RID	28089030105	1
258	-90.10635°	32.42144°	OLD CANTON RD AND RICE RD, MADISON COUNTY, MS	OLD CANTON RD / RICE RD RID	28089030107	1
259	-90.19897°	32.42370°	N LIVINGSTON RD AND ROUSER RD, MADISON COUNTY, MS	N LIVINGSTON RD / ROUSER RD RID	28089030205	1
260	-90.05459°	32.64028°	GREEN ACRES AND KING RANCH, MADISON COUNTY, MS	GREEN ACRES / KING RANCH CAN	28089030500	1
261	-89.73869°	32.69439°	E HWY 16 AND PERMENTER RD, MADISON COUNTY, MS	E HWY 16 / PERMENTER RD CAN	28089030900	1
262	-90.00299°	32.61638°	COVINGTON DR AND HWY 43, MADISON COUNTY, MS	COVINGTON DR / HWY 43 CAN	28089030600	1
263	-90.03262°	32.63559°	W HWY 16 AND OIL MILL QUARTERS RD, MADISON COUNTY, MS	W HWY 16 / OIL MILL QUARTERS RD CAN	28089030600	1
264	-90.34346°	32.52296°	W HWY 22, MADISON COUNTY, MS	W HWY 22 CAN	28089030302	1
265	-90.03489°	32.61513°	HWY 51 AND N MAD, MADISON COUNTY, MS	HWY 51 / N MAD CAN	28089030600	1
266	-90.04753°	32.61673°	349 WELCH ST, MADISON COUNTY, MS	349 WELCH ST CAN	28089030500	1
267	-90.18617°	32.51525°	HWY 463 AND REUNION BLVD, MADISON COUNTY, MS	HWY 463 / REUNION BLVD MAD	28089030301	1
268	-90.14445°	32.51688°	GLUCKSTADT RD AND KRISTEN HILL RD, MADISON COUNTY, MS	GLUCKSTADT RD / KRISTEN HILL RD CAN	28089030400	1
269	-90.05065°	32.61748°	390 RICKS DR, MADISON COUNTY, MS	390 RICKS DR CAN	28089030500	1
270	-89.93042°	32.78058°	LORING RD AND TUCKER RD, MADISON COUNTY, MS	LORING RD / TUCKER RD CAN	28089031000	1
271	-90.03503°	32.63808°	CMUANDRAILROAD, MADISON COUNTY, MS	CMU/RAILROAD CAN	28089030600	1
272	-90.16140°	32.43008°	OLD AGENCY RD AND DINSMOR CRSG, MADISON COUNTY, MS	OLD AGENCY RD / DINSMOR CRSG RID	28089030206	1
273	-90.08551°	32.51169°	HWY 51 AND YANDELL RD, MADISON COUNTY, MS	HWY 51 / YANDELL RD CAN	28089030400	1
274	-90.04385°	32.61013°	W ACADEMY ST AND S WALNUT ST, MADISON COUNTY, MS	W ACADEMY ST / S WALNUT ST CAN	28089030500	1
275	-90.30622°	32.53867°	POCAHONTAS RD AND WATSON ST, MADISON COUNTY, MS	POCAHONTAS RD / WATSON ST CAN	28089030302	1
276	-90.05491°	32.47240°	OLD RICE RD AND MADI, MADISON COUNTY, MS	OLD RICE RD / MADI CAN	28089030201	1
277	-90.01125°	32.74899°	WAY RD AND GRAY CENTER RD, MADISON COUNTY, MS	WAY RD / GRAY CENTER RD CAN	28089031000	1
278	-90.08907°	32.56426°	OLD JACKSON RD AND HILL RD, MADISON COUNTY, MS	OLD JACKSON RD / HILL RD CAN	28089030400	1
279	-90.04050°	32.60405°	TROLIO ST AND W DINKINS ST, MADISON COUNTY, MS	TROLIO ST / W DINKINS ST CAN	28089030700	1
280	-90.31698°	32.58353°	KEARNEY PARK RD AND MRS ST, MADISON COUNTY, MS	KEARNEY PARK RD / MRS ST CAN	28089030302	1
281	-90.21386°	32.46539°	LAKE CAVALIER ROAD AND SUNSET LANE, MADISON COUNTY, MS	Lake Cavalier Road / Sunset lane	28089030302	1
282	-90.04239°	32.60974°	S CANAL ST AND APPT COMPLEX, MADISON COUNTY, MS	S CANAL ST / APPT COMPLEX CAN	28089030500	1

Compiled Unique Roadblocks

Point ID *rid*	Longitude *lon*	Latitude *lat*	Clean Address *clean_address*	Original Address *original_address*	Census Tract ID *geoid*	Number of Roadblocks *num_rbs*
283	-90.13632°	32.53750°	CATLETT RD AND STRIBLING RD, MADISON COUNTY, MS	CATLETT RD / STRIBLING RD CAN	28089030400	1
284	-90 26086°	32.49780°	ROBINSON SPRINGS RD AND ROBINSON, MADISON COUNTY, MS	ROBINSON SPRINGS RD / ROBINSON CAN	28089030302	1
285	-90.14391°	32.43605°	I-55 S AND RIDGELAND, MADISON COUNTY, MS	I-55 S / RIDGELAND CAN	28089030101	1
286	-90 04675°	32.61556°	BOYD ST, MADISON COUNTY, MS	Boyd St	28089030500	1
287	-90 08698°	32.41514°	BREAKERS LN, MADISON COUNTY, MS	BREAKERS LN CAN	28089030107	1
288	-90 04016°	32.49513°	TWELVE OAKS RD AND OLD CANTON RD, MADISON COUNTY, MS	TWELVE OAKS RD / OLD CANTON RD CAN	28089030201	1
289	-90 03969°	32.64034°	GREEN ACRES DR AND HWY 16W, MADISON COUNTY, MS	GREEN ACRES DR / HWY 16W CAN	28089030500	1
290	-90.13686°	32.54157°	TYLER LN AND CATLETT RD, MADISON COUNTY, MS	TYLER LN / CATLETT RD CAN	28089030400	1
291	-90 20355°	32.40807°	LIVINGSTON RD AND PEATRY PENDLETON, MADISON COUNTY, MS	LIVINGSTON RD / PEATRY PENDLETON RID	28089030206	1
292	-90 03133°	32.51693°	43 AND YANDELL RD, MADISON COUNTY, MS	43 / YANDELL RD CAN	28089030400	1
293	-90 05483°	32.61846°	KING RANCH RD AND GEORGE WASHINGTON AVE, MADISON COUNTY, MS	KING RANCH RD / GEORGE WASHINGTON AVE CAN	28089030500	1
294	-90.15555°	32.43023°	NATCHEZ TRACE AND GREENWOOD XING, MADISON COUNTY, MS	NATCHEZ TRACE / GREENWOOD XING RID	28089030206	1
295	-89 99463°	32.61118°	E HWY 16 AND COUNTRY CLUB DR, MADISON COUNTY, MS	E HWY 16 / COUNTRY CLUB DR CAN	28089030800	1
296	-89 93830°	32.78063°	LORING RD AND HARGON RD, MADISON COUNTY, MS	LORING RD / HARGON RD CAN	28089031000	1
297	-90 03336°	32.74445°	WAY RD AND WAY CIR, MADISON COUNTY, MS	WAY RD / WAY CIR CAN	28089031000	1
298	-90.10635°	32.43982°	RIDGECREST DR AND OLD CANTON RD, MADISON COUNTY, MS	RIDGECREST DR / OLD CANTON RD MAD	28089030101	1
299	-90 04935°	32.61853°	MACE STREET AND GEORGE WASHINGTON ST, MADISON COUNTY, MS	Mace Street / George Washington St	28089030500	1
300	-89 94203°	32.85523°	HWY 17 AND OLD 51 RD, MADISON COUNTY, MS	HWY 17 / OLD 51 RD PIC	28089031000	1
301	-90.11235°	32.40999°	NORTH PARK DR AND FONTAINE PL, MADISON COUNTY, MS	NORTH PARK DR / FONTAINE PL CAN	28089030106	1
302	-90.11094°	32.46031°	YANDELL AND MADISON CROSSING, MADISON COUNTY, MS	YANDELL / MADISON CROSSING CAN	28089030202	1
303	-90.14668°	32.53369°	SYCAMORE RIDGE AND ASHBROOKE BLV, MADISON COUNTY, MS	SYCAMORE RIDGE / ASHBROOKE BLV CAN	28089030400	1
304	-90 00198°	32.61001°	PEACE ST, MADISON COUNTY, MS	PEACE ST CAN	28089030600	1
305	-90 33811°	32.55318°	COX FERRY RD AND OLD HWY 49, MADISON COUNTY, MS	COX FERRY RD / OLD HWY 49 FLO	28089030302	1
306	-90 03286°	32.63661°	HWY 16 AND OIL MILL QUARTERS RD, MADISON COUNTY, MS	HWY 16 / OIL MILL QUARTERS RD CAN	28089030600	1
307	-90 31290°	32.54469°	FIRST ST AND CENTER ST, MADISON COUNTY, MS	FIRST ST / CENTER ST FLO	28089030302	1
308	-89 99716°	32.58401°	1528 HWY 43, MADISON COUNTY, MS	1528 HWY 43 CAN	28089030900	1
309	-90 04543°	32.61137°	ROBY ST AND W FULTON ST, MADISON COUNTY, MS	ROBY ST / W FULTON ST CAN	28089030500	1
310	-90 09464°	32.51365°	WEISENBERGER ROAD AND PARKWAY EAST, MADISON COUNTY, MS	Weisenberger Road / Parkway East	28089030204	1
311	-90 04283°	32.60405°	W DINKINS ST AND RANGE, MADISON COUNTY, MS	W DINKINS ST / RANGE CAN	28089030700	1
312	-90 05379°	32.62360°	HOLMES AVENUE AND WAYNE DRIVE, MADISON COUNTY, MS	Holmes Avenue/Wayne Drive	28089030500	1
313	-90 02437°	32.62048°	MILLER ST AND LINCOLN ST, MADISON COUNTY, MS	MILLER ST / LINCOLN ST CAN	28089030600	1
314	-89.79151°	32.75230°	HWY 43 AND HONEYSUCKER RD, MADISON COUNTY, MS	HWY 43 / HONEYSUCKER RD CAN	28089031000	1
315	-90.11650°	32.46476°	MADISON PARKWAY AND POST OAK RD, MADISON COUNTY, MS	MADISON PARKWAY / POST OAK RD MAD	28089030203	1
316	-90 09157°	32.49991°	1556 HWY 51, MADISON COUNTY, MS	1556 HWY 51 MAD	28089030201	1
317	-90 05488°	32.47242°	OLD RICE RD AND CHANNEL LN, MADISON COUNTY, MS	OLD RICE RD / CHANNEL LN MAD	28089030201	1
318	-90 31023°	32.54490°	111 KEARNEY PARK RD, MADISON COUNTY, MS	111 KEARNEY PARK RD FLO	28089030302	1
319	-90 05585°	32.47233°	OLD RICE AND HALEY CREEK, MADISON COUNTY, MS	OLD RICE / HALEY CREEK CAN	28089030201	1
320	-90 04889°	32.62275°	1006 HOLMES AV, MADISON COUNTY, MS	1006 HOLMES AV CAN	28089030500	1
321	-89 98647°	32.61325°	HWY 16 AND GREENFIELD DR, MADISON COUNTY, MS	HWY 16 / GREENFIELD DR CAN	28089030900	1
322	-90.10094°	32.48181°	HWY 51 AND TISDALE RD, MADISON COUNTY, MS	HWY 51 / TISDALE RD MAD	28089030203	1
323	-90 08110°	32.56065°	NISSAN AND I-55, MADISON COUNTY, MS	NISSAN / I-55 CAN	28089030400	1
324	-90 03939°	32.60859°	CAMERON ST AND LEE ST, MADISON COUNTY, MS	CAMERON ST / LEE ST CAN	28089030700	1
325	-90 09635°	32.42126°	RICE RD AND HARBOR DR, MADISON COUNTY, MS	RICE RD / HARBOR DR CAN	28089030107	1
326	-90 05480°	32.62393°	KING RANCH AND PARKVIEW, MADISON COUNTY, MS	KING RANCH / PARKVIEW CAN	28089030500	1
327	-90 07202°	32.46506°	HOY RD AND N OLD CANTON RD, MADISON COUNTY, MS	HOY RD / N OLD CANTON RD CAN	28089030201	1
328	-90 06374°	32.55366°	HIGHWAY 51 AND SOUTH LIBERTY, MADISON COUNTY, MS	Highway 51 / South Liberty	28089030400	1
329	-89 83846°	32.78040°	HWY 17 AND MCCARTY RD, MADISON COUNTY, MS	HWY 17 / MCCARTY RD CAM	28089031000	1

Compiled Unique Roadblocks

Point ID *rid*	Longitude *lon*	Latitude *lat*	Clean Address *clean_address*	Original Address *original_address*	Census Tract ID *geoid*	Number of Roadblocks *num_rbs*
330	-90 32426°	32.58966°	LIVINGSTON VERNON AND ST CHARLE, MADISON COUNTY, MS	LIVINGSTON VERNON / ST CHARLE CAN	28089030302	1
331	-90 31217°	32.55143°	KEARNEY PARK RD AND COURT ST, MADISON COUNTY, MS	KEARNEY PARK RD / COURT ST FLO	28089030302	1
332	-90 04385°	32.61134°	WALNUT ST AND W FULTON ST, MADISON COUNTY, MS	WALNUT ST / W FULTON ST CAN	28089030500	1
333	-89 87865°	32.62209°	ROBINSON RD AND PLEASANT GIFT RD, MADISON COUNTY, MS	ROBINSON RD / PLEASANT GIFT RD CAN	28089030900	1
334	-90.11325°	32.45780°	HWY 51 AND MADISON AVE, MADISON COUNTY, MS	HWY 51 / MADISON AVE CAN	28089030203	1
335	-90.10721°	32.46508°	HOY RD AND OLD CANTON RD, MADISON COUNTY, MS	HOY RD / OLD CANTON RD CAN	28089030202	1
336	-89 93550°	32.64578°	1400 SHARON RD, MADISON COUNTY, MS	1400 SHARON RD CAN	28089030900	1
337	-90.17773°	32.53660°	103 N I-55, MADISON COUNTY, MS	103 N I-55 RID	28089030400	1
338	-90 32935°	32.58968°	LIVINGSTON VERNON RD AND EMMIT R, MADISON COUNTY, MS	LIVINGSTON VERNON RD / EMMIT R CAN	28089030302	1
339	-89 96319°	32.65553°	GOODLOE RD , HWY 43, MADISON COUNTY, MS	GOODLOE RD , HWY 43 CAN	28089030900	1
340	-89 93564°	32.65857°	HWY 43 AND GOO, MADISON COUNTY, MS	HWY 43 / GOO CAN	28089030900	1
341	-90.13520°	32.54155°	TYLER LN AND CAT, MADISON COUNTY, MS	TYLER LN / CAT CAN	28089030400	1
342	-90 04442°	32.58665°	2941 HWY 51, MADISON COUNTY, MS	2941 HWY 51 CAN	28089030400	1
343	-90 08921°	32.53161°	CHURCH RD AND OLD JACKSON RD, MADISON COUNTY, MS	CHURCH RD / OLD JACKSON RD CAN	28089030400	1
344	-90 01306°	32.51666°	YANDELL RD AND BAINBRIDGE CROSSI, MADISON COUNTY, MS	YANDELL RD / BAINBRIDGE CROSSI MAD	28089030900	1
345	-90.11871°	32.46293°	MAIN ST AND POST OAK RD, MADISON COUNTY, MS	MAIN ST / POST OAK RD CAN	28089030203	1
346	-90 09119°	32.52016°	N INDUSTRIAL BLVD, MADISON COUNTY, MS	N INDUSTRIAL BLVD CAN	28089030400	1
347	-90.10640°	32.42712°	OLD CANTON RD AND NATCHEZ TRACE, MADISON COUNTY, MS	OLD CANTON RD / NATCHEZ TRACE RID	28089030101	1
348	-90 31714°	32.58966°	KEARNEY PARK AND LIVINGSTON VERNON, MADISON COUNTY, MS	KEARNEY PARK / LIVINGSTON VERNON CAN	28089030302	1
349	-90.15925°	32.66291°	HWY 22 AND PANTHER CREEK, MADISON COUNTY, MS	HWY 22 / PANTHER CREEK CAN	28089030400	1
350	-90 08528°	32.66191°	WILLIAMS BLVD, MADISON COUNTY, MS	WILLIAMS BLVD CAN	28089030400	1
351	-90 22227°	32.49411°	ROBINSON SPRING RD AND COKER RD, MADISON COUNTY, MS	ROBINSON SPRING RD / COKER RD CAN	28089030302	1
352	-90.10136°	32.40217°	PINE KNOLL CT, MADISON COUNTY, MS	PINE KNOLL CT RID	28089030108	1
353	-90 01058°	32.61731°	COVINGTON DRIVE AND CISNE AVE, MADISON COUNTY, MS	Covington Drive / Cisne Ave	28089030600	1
354	-90 04671°	32.61298°	108 BOYD STREET, MADISON COUNTY, MS	108 Boyd Street	28089030500	1
355	-89 96808°	32.64185°	HWY 43 AND QUAIL RD, MADISON COUNTY, MS	HWY 43 / QUAIL RD CAN	28089030900	1
356	-90 09279°	32.49762°	HWY 51 AND GROSS RD, MADISON COUNTY, MS	HWY 51 / GROSS RD MAD	28089030204	1
357	-90 30010°	32.56464°	HARRIS RD AND HARRIS SUBDIVISION, MADISON COUNTY, MS	HARRIS RD / HARRIS SUBDIVISION FLO	28089030302	1
358	-90 07841°	32.60265°	HWY 22 AND VIRLILIA RD, MADISON COUNTY, MS	HWY 22 / VIRLILIA RD CAN	28089030400	1
359	-90.17783°	32.42745°	OLD AGENCY RD AND PATTERSON, MADISON COUNTY, MS	OLD AGENCY RD / PATTERSON CAN	28089030205	1
360	-89 93050°	32.65864°	OLD HWY 16 AND ROBERT DEARON RD, MADISON COUNTY, MS	OLD HWY 16 / ROBERT DEARON RD CAN	28089030900	1
361	-90 03486°	32.61856°	UNION ST AND LIBERTY ST, MADISON COUNTY, MS	UNION ST / LIBERTY ST CAN	28089030600	1

Source: Funderburk Report, Appendix D

Appendix D1

Near Analysis

Census Tract ID within 20 Meters of the Road Block	Census Tract ID Assigned by Dr. Ricchetti	Point ID	Longitude	Latitude	Number of Roadblocks	Near Distance (Meters)[1]	Near Rank[2]	Percent Black Population for Census Tract Assigned by Dr. Ricchetti	Percent Black Population for Census Tract within 20 Meters of the Road Block	Max Percent Black Population of All Tracts within 20 Meters of the Road Block	Min Percent Black Population of All Tracts within 20 Meters of the Road Block	Could be More Black[3]	Could be Less Black[4]	Number of Roadblocks Could be More Black[5]	Number of Roadblocks Could be Less Black[6]
near_geoid	*rb_geoid*	*rid*	*lon*	*lat*	*num_rbs*	*NEAR_DIST*	*NEAR_RANK*	*rb_pctblack*	*near_pctblack*	*max_pctblack*	*min_pctblack*	*could_be_moreblack*	*could_be_lessblack*	*num_rbs_could_be_more_black*	*num_rbs_could_be_less_black*
28089030101	28089030101	141	-90.12996°	32.42631°	2	0.00	1	10.7%	10.7%	46.2%	10.7%	1	0	2	0
28089030101	28089030101	194	-90.11701°	32.45051°	1	0.00	1	10.7%	10.7%	11.6%	10.7%	1	0	1	0
28089030101	28089030101	347	-90.10640°	32.42712°	1	0.00	1	10.7%	10.7%	18.0%	10.7%	1	0	1	0
28089030101	28089030101	188	-90.10644°	32.45044°	1	0.00	1	10.7%	10.7%	10.9%	10.7%	1	0	1	0
28089030104	28089030104	77	-90.10902°	32.41405°	5	0.00	1	16.5%	16.5%	47.6%	16.5%	1	0	5	0
28089030104	28089030104	67	-90.12352°	32.42500°	6	0.00	1	16.5%	16.5%	46.2%	16.5%	1	0	6	0
28089030104	28089030104	244	-90.10638°	32.41625°	1	0.00	1	16.5%	16.5%	18.0%	16.5%	1	0	1	0
28089030105	28089030105	59	-90.14375°	32.42818°	7	0.00	1	46.2%	46.2%	46.2%	10.7%	0	1	0	7
28089030106	28089030106	237	-90.11382°	32.41400°	1	0.00	1	47.6%	47.6%	47.6%	16.5%	0	1	0	1
28089030106	28089030106	4	-90.10804°	32.40255°	59	0.00	1	47.6%	47.6%	65.6%	47.6%	1	0	59	0
28089030106	28089030106	20	-90.10651°	32.40515°	19	0.00	1	47.6%	47.6%	65.6%	47.6%	1	0	19	0
28089030106	28089030106	234	-90.13148°	32.39951°	1	0.00	1	47.6%	47.6%	47.6%	47.6%	0	0	0	0
28089030106	28089030106	25	-90.13207°	32.40682°	17	0.00	1	47.6%	47.6%	47.6%	46.2%	0	1	0	17
28089030106	28089030106	22	-90.10835°	32.41099°	18	0.00	1	47.6%	47.6%	65.6%	47.6%	1	0	18	0
28089030107	28089030107	3	-90.08861°	32.41169°	65	0.53	2	18.0%	18.0%	65.6%	18.0%	1	0	65	0
28089030107	28089030107	18	-90.09314°	32.41200°	20	0.00	1	18.0%	18.0%	65.6%	18.0%	1	0	20	0
28089030107	28089030107	258	-90.10635°	32.42144°	1	0.00	1	18.0%	18.0%	18.0%	16.5%	0	1	0	1
28089030108	28089030108	110	-90.10625°	32.41099°	4	0.00	1	65.6%	65.6%	65.6%	47.6%	0	1	0	4
28089030108	28089030108	53	-90.08884°	32.41167°	8	0.00	1	65.6%	65.6%	65.6%	18.0%	0	1	0	8
28089030201	28089030201	14	-89.97501°	32.52461°	25	0.00	1	18.6%	18.6%	69.5%	18.6%	1	0	25	0
28089030201	28089030201	203	-89.97251°	32.52276°	1	0.00	1	18.6%	18.6%	69.5%	18.6%	1	0	1	0
28089030201	28089030201	49	-89.97754°	32.52706°	9	0.00	1	18.6%	18.6%	69.5%	18.6%	1	0	9	0
28089030201	28089030201	316	-90.09157°	32.49991°	1	0.00	1	18.6%	18.6%	18.6%	14.7%	0	1	0	1
28089030201	28089030201	51	-89.99343°	32.51694°	8	0.00	1	18.6%	18.6%	69.5%	18.6%	1	0	8	0
28089030202	28089030202	113	-90.09117°	32.46505°	3	0.00	1	10.9%	10.9%	18.6%	10.9%	1	0	3	0
28089030203	28089030203	334	-90.11325°	32.45780°	1	0.00	1	11.6%	11.6%	11.6%	10.9%	0	1	0	1
28089030203	28089030203	122	-90.10952°	32.46509°	3	0.36	2	11.6%	11.6%	11.6%	10.9%	0	1	0	3
28089030203	28089030203	322	-90.10094°	32.48181°	1	0.00	1	11.6%	11.6%	18.6%	11.6%	1	0	1	0
28089030204	28089030204	108	-90.09547°	32.49241°	4	0.31	2	14.7%	14.7%	18.6%	14.7%	1	0	4	0
28089030204	28089030204	17	-90.17293°	32.45587°	21	0.00	1	14.7%	14.7%	17.9%	14.7%	1	0	21	0
28089030204	28089030204	356	-90.09279°	32.49762°	1	0.00	1	14.7%	14.7%	18.6%	14.7%	1	0	1	0
28089030205	28089030205	359	-90.17763°	32.42745°	1	0.00	1	17.9%	17.9%	17.9%	13.0%	0	1	0	1
28089030205	28089030205	259	-90.19897°	32.42370°	1	0.00	1	17.9%	17.9%	49.3%	13.0%	1	1	1	1
28089030206	28089030206	139	-90.20283°	32.40014°	2	0.89	1	13.0%	13.0%	13.0%	13.0%	0	0	0	0
28089030206	28089030206	39	-90.17659°	32.40026°	11	0.00	1	13.0%	13.0%	46.2%	13.0%	1	0	11	0
28089030206	28089030206	37	-90.19989°	32.42081°	11	0.00	1	13.0%	13.0%	17.9%	13.0%	1	0	11	0
28089030206	28089030206	101	-90.18200°	32.40020°	4	0.37	1	13.0%	13.0%	13.0%	13.0%	0	0	0	0
28089030206	28089030206	154	-90.19946°	32.42228°	2	0.00	1	13.0%	13.0%	17.9%	13.0%	1	0	2	0
28089030206	28089030206	1	-90.17706°	32.40025°	114	0.00	1	13.0%	13.0%	13.0%	13.0%	0	0	0	0
28089030301	28089030301	80	-90.15769°	32.51791°	5	0.00	1	11.6%	11.6%	28.0%	11.6%	1	0	5	0
28089030301	28089030301	33	-90.19194°	32.52423°	12	0.00	1	11.6%	11.6%	28.0%	11.6%	1	0	12	0
28089030301	28089030301	233	-90.14138°	32.51689°	1	0.00	1	11.6%	11.6%	28.0%	11.6%	1	0	1	0
28089030301	28089030301	177	-90.13915°	32.49762°	2	0.00	1	11.6%	11.6%	14.7%	11.6%	1	0	2	0
28089030301	28089030301	196	-90.16147°	32.51903°	1	0.00	1	11.6%	11.6%	28.0%	11.6%	1	0	1	0
28089030302	28089030302	189	-90.19880°	32.43164°	1	0.00	1	49.3%	49.3%	49.3%	17.9%	0	1	0	1
28089030302	28089030302	118	-90.20074°	32.48393°	3	0.00	1	49.3%	49.3%	49.3%	11.6%	0	1	0	3
28089030302	28089030302	50	-90.24606°	32.56062°	8	0.25	2	49.3%	49.3%	49.3%	28.0%	0	1	0	8
28089030302	28089030302	43	-90.18657°	32.45495°	10	0.00	1	49.3%	49.3%	49.3%	14.7%	0	1	0	10
28089030302	28089030302	243	-90.17900°	32.47503°	1	0.00	1	49.3%	49.3%	49.3%	14.7%	0	1	0	1
28089030302	28089030302	64	-90.20088°	32.44432°	7	0.00	1	49.3%	49.3%	49.3%	17.9%	0	1	0	7
28089030400	28089030400	100	-90.07054°	32.51711°	4	0.00	1	28.0%	28.0%	28.0%	18.6%	0	1	0	4
28089030400	28089030400	127	-90.07056°	32.51712°	3	0.00	1	28.0%	28.0%	28.0%	18.6%	0	1	0	3
28089030400	28089030400	248	-90.10138°	32.51712°	1	0.00	1	28.0%	28.0%	28.0%	14.7%	0	1	0	1
28089030400	28089030400	151	-90.07205°	32.51708°	2	0.09	2	28.0%	28.0%	28.0%	18.6%	0	1	0	2

Near Analysis

Census Tract ID within 20 Meters of the Road Block *near_geoid*	Census Tract ID Assigned by Dr. Ricchetti *rb_geoid*	Point ID *rid*	Longitude *lon*	Latitude *lat*	Number of Roadblocks *num_rbs*	Near Distance (Meters)[1] *NEAR_DIST*	Near Rank[2] *NEAR_RANK*	Percent Black Population for Census Tract Assigned by Dr. Ricchetti *rb_pctblack*	Percent Black Population for Census Tract within 20 Meters of the Road Block *near_pctblack*	Max Percent Black Population of All Tracts within 20 Meters of the Road Block *max_pctblack*	Min Percent Black Population of All Tracts within 20 Meters of the Road Block *min_pctblack*	Could be More Black[3] *could_be morablack*	Could be Less Black[4] *could_be lessblack*	Number of Roadblocks Could be More Black[5] *num_rbs_could be_more_black*	Number of Roadblocks Could be Less Black[6] *num_rbs_could be_less_black*
28089030400	28089030400	268	-90.14445°	32.51688°	1	0.47	2	28.0%	28.0%	28.0%	11.6%	0	1	0	1
28089030400	28089030400	273	-90.08551°	32.51169°	1	0.07	2	28.0%	28.0%	28.0%	14.7%	0	1	0	1
28089030400	28089030400	98	-90.07176°	32.51710°	4	0.00	1	28.0%	28.0%	28.0%	18.6%	0	1	0	4
28089030400	28089030400	255	-90.02883°	32.51694°	1	0.16	2	28.0%	28.0%	28.0%	18.6%	0	1	0	1
28089030400	28089030400	161	-90.07616°	32.51581°	2	0.00	1	28.0%	28.0%	28.0%	18.6%	0	1	0	2
28089030400	28089030400	89	-90.13200°	32.51692°	4	0.00	1	28.0%	28.0%	28.0%	11.6%	0	1	0	4
28089030400	28089030400	292	-90.03133°	32.51693°	1	0.00	1	28.0%	28.0%	28.0%	18.6%	0	1	0	1
28089030500	28089030500	211	-90.05476°	32.63267°	1	0.00	1	89.5%	89.5%	89.5%	28.0%	0	1	0	1
28089030500	28089030500	289	-90.03969°	32.64034°	1	0.00	1	89.5%	89.5%	89.5%	28.0%	0	1	0	1
28089030500	28089030500	260	-90.05459°	32.64026°	1	0.00	1	89.5%	89.5%	89.5%	28.0%	0	1	0	1
28089030500	28089030500	72	-90.03845°	32.62370°	6	0.00	1	89.5%	89.5%	89.5%	83.7%	0	1	0	6
28089030500	28089030500	11	-90.03488°	32.64034°	32	0.00	1	89.5%	89.5%	89.5%	28.0%	0	1	0	32
28089030600	28089030600	157	-89.96033°	32.62167°	2	0.00	1	83.7%	83.7%	83.7%	69.5%	0	1	0	2
28089030600	28089030600	304	-90.00198°	32.61001°	1	0.00	1	83.7%	83.7%	83.7%	59.6%	0	1	0	1
28089030600	28089030600	235	-90.00818°	32.61122°	1	0.14	2	83.7%	83.7%	83.7%	59.6%	0	1	0	1
28089030600	28089030600	8	-90.03373°	32.64035°	38	0.00	1	83.7%	83.7%	83.7%	69.5%	0	1	0	38
28089030600	28089030600	115	-90.01183°	32.63320°	3	0.00	1	83.7%	83.7%	83.7%	69.5%	0	1	0	3
28089030600	28089030600	271	-90.03503°	32.63808°	1	0.00	1	83.7%	83.7%	89.5%	83.7%	1	0	1	0
28089030600	28089030600	19	-89.98714°	32.61306°	19	0.57	2	83.7%	83.7%	83.7%	59.6%	0	1	0	19
28089030700	28089030700	168	-90.03491°	32.60404°	2	0.00	1	58.4%	58.4%	59.6%	58.4%	1	0	2	0
28089030800	28089030800	295	-89.99463°	32.61118°	1	0.00	1	59.6%	59.6%	83.7%	59.6%	1	0	1	0
28089030800	28089030800	158	-90.02995°	32.61016°	2	0.00	1	59.6%	59.6%	59.6%	58.4%	0	1	0	2
28089030900	28089030900	321	-89.98647°	32.61325°	1	0.00	1	69.5%	69.5%	83.7%	59.6%	1	1	1	1
28089030900	28089030900	107	-89.76596°	32.74020°	4	0.00	1	69.5%	69.5%	84.0%	69.5%	1	0	4	0
28089030900	28089030900	240	-89.96975°	32.61860°	1	0.00	1	69.5%	69.5%	83.7%	69.5%	1	0	1	0
28089030900	28089030900	124	-89.96964°	32.52200°	3	0.00	1	69.5%	69.5%	69.5%	18.6%	0	1	0	3
28089030900	28089030900	344	-90.01306°	32.51686°	1	0.00	1	69.5%	69.5%	69.5%	18.6%	0	1	0	1
28089031000	28089031000	85	-89.80946°	32.71561°	5	0.00	1	84.0%	84.0%	84.0%	69.5%	0	1	0	5

Source: Funderburk Report, Appendix D; Mississippi Transverse Mercator NAD83 Projection; Madison County Census Tract Polygon Data

Note:
[1] The distance in meters returned by the Near Analysis between the road block point and the nearest boundary of the Census Tract ID referenced by the "Census Tract ID within 20 Meters of the Road Block." This value is between zero (indicating the point is in the poly) and 20 meters.
[2] If more than one Census Tract is within 20 meters of the road block point, the rank indicates the order in which they are closest (the closest being 1).
[3] A value of 1 if the "Percent Black Population for Census Tract Assigned by Dr. Ricchetti" is less than the "Max Percent Black Population of All Tracts within 20 Meters of the Road Block."
[4] A value of 1 if the "Percent Black Population for Census Tract Assigned by Dr. Ricchetti" is more than the "Min Percent Black Population of All Tracts within 20 Meters of the Road Block."
[5] The "Number of Roadblocks" times the value of "Could be More Black."
[6] The "Number of Roadblocks" times the value of "Could be Less Black."

Appendix D2

Near Analysis

Point ID *rid*	Clean Address *clean_addr*
141	HWY 51 AND NATCHEZ TRACE, MADISON COUNTY, MS
194	HWY 51 AND ST AUGUSTINE DR, MADISON COUNTY, MS
347	OLD CANTON RD AND NATCHEZ TRACE, MADISON COUNTY, MS
188	OLD CANTON RD AND ST AUGUSTINE D, MADISON COUNTY, MS
77	LAKE HARBOUR DRIVE AND RANKIN, MADISON COUNTY, MS
67	RICE RD AND PEAR ORCHARD RD, MADISON COUNTY, MS
244	OLD CANTON RD AND MRA, MADISON COUNTY, MS
59	NATCHEZ TRACE PKWY AND I-55, MADISON COUNTY, MS
237	711 LAKE HARBOUR DR, MADISON COUNTY, MS
4	OLD CANTON RD AND PINE KNOLL DR, MADISON COUNTY, MS
20	OLD CANTON RD AND WILLIAM BLVD, MADISON COUNTY, MS
234	EAST COUNTY LINE ROAD AND MOSSLINE DRIVE, MADISON COUNTY, MS
25	TOWNE CENTER AND WHEATLEY, MADISON COUNTY, MS
22	HARBOUR PT XING AND OLD CANTON, MADISON COUNTY, MS
3	LOWER SPILLWAY RD, MADISON COUNTY, MS
18	HARBOR AND LAKE HARBOR, MADISON COUNTY, MS
258	OLD CANTON RD AND RICE RD, MADISON COUNTY, MS
110	HARBOUR POINTE CROSSING AND NORT, MADISON COUNTY, MS
53	SPILLWAY RD AND BREAKERS LN, MADISON COUNTY, MS
14	HWY 43 AND NATCHEZ TRACE PKWY, MADISON COUNTY, MS
203	HWY 43 AND BROWNS LANDING RD, MADISON COUNTY, MS
49	HWY 43 AND YANDELL RD, MADISON COUNTY, MS
316	1556 HWY 51, MADISON COUNTY, MS
51	YANDELL RD AND TWELVE OAKS TRACE, MADISON COUNTY, MS
113	HOY RD AND RICE RD, MADISON COUNTY, MS
334	HWY 51 AND MADISON AVE, MADISON COUNTY, MS
122	HWY 463 AND MADISON MIDDLE, MADISON COUNTY, MS
322	HWY 51 AND TISDALE RD, MADISON COUNTY, MS
108	HWY 51 AND GREEN OAK LN, MADISON COUNTY, MS
17	LAKE CASTLE RD AND RICHARDSON RD, MADISON COUNTY, MS
356	HWY 51 AND GROSS RD, MADISON COUNTY, MS
359	OLD AGENCY RD AND PATTERSON, MADISON COUNTY, MS
259	N LIVINGSTON RD AND ROUSER RD, MADISON COUNTY, MS
139	N LIVINGSTON RD AND COUNTY LINE, MADISON COUNTY, MS
39	I-220 AND W COUNTY LINE RD, MADISON COUNTY, MS
37	LIVINGSTON RD AND OLD AGENCY RD, MADISON COUNTY, MS
101	W COUNTY LINE AND HIGHLAND COLONY, MADISON COUNTY, MS
154	N LIVINGSTON RD AND NATCHEZ TRACE BRIDGE, MADISON COUNTY, MS
1	W COUNTY LINE RD AND I-220, MADISON COUNTY, MS
80	GLUCKSTADT RD AND DEWEES RD, MADISON COUNTY, MS
33	HWY 463 AND GLUCKSTADT RD, MADISON COUNTY, MS
233	GLUCKSTADT RD AND C STORE, MADISON COUNTY, MS
177	BOZEMAN RD AND REUNION ANNANDALE, MADISON COUNTY, MS
196	463 AND GLUCKSTADT RD, MADISON COUNTY, MS
189	N LIVINGSTON RD AND COU, MADISON COUNTY, MS
118	ROBINSON SPRINGS RD AND POC, MADISON COUNTY, MS
50	LIVINGSTON VERNON RD AND STOKES, MADISON COUNTY, MS
43	N LIVINGSTON RD AND LAKE CASTLE RD, MADISON COUNTY, MS
243	N LIVINGSTON RD AND MCDONALD DR, MADISON COUNTY, MS

Near Analysis

Point ID *rid*	Clean Address *clean_addr*
64	LAKE CAVALIER RD AND N LIVINGSTO, MADISON COUNTY, MS
100	YANDELL RD AND MADISON CROSSING, MADISON COUNTY, MS
127	300 YANDELL RD, MADISON COUNTY, MS
248	N. I-55 AND GLUCKSTADT ROAD, MADISON COUNTY, MS
151	YANDELL RD AND BRACEY RD, MADISON COUNTY, MS
268	GLUCKSTADT RD AND KRISTEN HILL RD, MADISON COUNTY, MS
273	HWY 51 AND YANDELL RD, MADISON COUNTY, MS
98	YANDELL RD AND CLARKDELL RD, MADISON COUNTY, MS
255	YANDELL RD AND DEERFIELD BLVD, MADISON COUNTY, MS
161	YANDELL RD AND CLARKDELL RD EXT, MADISON COUNTY, MS
89	GLUCKSTADT RD AND CATLETT RD, MADISON COUNTY, MS
292	43 AND YANDELL RD, MADISON COUNTY, MS
211	HEINDL RD AND KING RANCH RD, MADISON COUNTY, MS
289	GREEN ACRES DR AND HWY 16W, MADISON COUNTY, MS
260	GREEN ACRES AND KING RANCH, MADISON COUNTY, MS
72	RAILROAD ST AND MARTIN LUTHER KI, MADISON COUNTY, MS
11	GREEN ACRES AND RAILROAD ST, MADISON COUNTY, MS
157	E HWY 16 AND ROYAL OAK RD, MADISON COUNTY, MS
304	PEACE ST, MADISON COUNTY, MS
235	HWY 16 AND HWY 43, MADISON COUNTY, MS
8	W HWY 16 AND GREEN ACRES, MADISON COUNTY, MS
115	FINNEY RD AND MORGAN RD, MADISON COUNTY, MS
271	CMUANDRAILROAD, MADISON COUNTY, MS
19	HWY 16 AND AVONDALE RD, MADISON COUNTY, MS
166	S LIBERTY ST AND W DINKINS ST, MADISON COUNTY, MS
295	E HWY 16 AND COUNTRY CLUB DR, MADISON COUNTY, MS
158	ACADEMY ST AND LYON ST, MADISON COUNTY, MS
321	HWY 16 AND GREENFIELD DR, MADISON COUNTY, MS
107	SULPHUR SPRING RD AND GIN RD, MADISON COUNTY, MS
240	E HWY 16 AND ROBINSON RD, MADISON COUNTY, MS
124	HWY 43 AND TURCOTTE LAB DR, MADISON COUNTY, MS
344	YANDELL RD AND BAINBRIDGE CROSSI, MADISON COUNTY, MS
85	HWY 17 AND SULPHUR SPRINGS RD, MADISON COUNTY, MS

Source: Funderburk Report, Appendix D; Mississippi Transverse Mercator NAD83 Projection; Madison County Census Tract Polygon Data

EXHIBIT 3

UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF MISSISSIPPI
JACKSON DIVISION

LATOYA BROWN; LAWRENCE BLACKMON; HERBERT ANTHONY GREEN; KHADAFY MANNING; QUINNETTA MANNING; MARVIN MCFIELD; NICHOLAS SINGLETON; STEVEN SMITH; BESSIE THOMAS; and BETTY JEAN WILLIAMS TUCKER, individually and on behalf of a class of all others similarly situated, *Plaintiffs*, v. MADISON COUNTY, MISSISSIPPI; SHERIFF RANDALL S. TUCKER, in his official capacity; and MADISON COUNTY SHERIFF'S DEPUTIES JOHN DOES #1 through #6, in their individual capacities, *Defendants*.	Civil Action No. 3:17-cv-00347-WHB-LRA

REBUTTAL EXPERT REPORT OF BRYAN RICCHETTI, Ph.D.

July 2, 2018

Table of Contents

1. SUMMARY OF FINDINGS

1. Since filing my initial report on March 13, 2018, I have reviewed the reports of Dr. Steward and Mr. Funderburk. In this report, I address the claims made in those two reports. In particular, I explain how Dr. Steward's claims that my methodology is unreliable stem from a misunderstanding of widely accepted econometric methods. As I detail below, this is evidenced by the fact that the methods I use are widely accepted in both academia and by the Courts. Further, Dr. Steward and Mr. Funderburk overstate the extent of certain data issues, and do not use widely accepted statistical methods to test whether my findings are sensitive to the various data issues they identify. As I show below, my results are robust to each of the claims made.

2. I begin my analysis in Section 2, where I address a variety of claims that Dr. Steward makes about the methodology of my model and its use in the academic literature. As I explain in that section, Dr. Steward misunderstands how my model works, and incorrectly asserts that my methodological approach is not used in the academic literature. The methodology I use has been used in published academic work and has been accepted by Courts. In fact, Dr. Steward has himself used the general methodology in prior work as an expert witness. Below is a summary of my key findings on these points:

- Dr. Steward claims that my model does not account for the driving population.[1] This is simply untrue. Consistent with the academic literature on policing that I cite to in my original report (and that Dr. Steward cites to in his report), my analysis controls directly for the population of motorists who most directly contribute to roadblock placement, using data from MCSD on DUIs and traffic violations. In fact, Dr. Steward asserts that "the key factor in MCSD traffic roadblock location placement" is DUI frequency of motorists, which is the central control variable in my model.[2] Yet despite the fact that DUI frequency

[1] Rebuttal Report of Dwight D. Steward, Ph.D. RE: Bryan Ricchetti, Ph.D., May 8, 2018 ("Steward Report"), ¶ 38.
[2] Steward Report, ¶¶ 54–61.

is included in my model, Dr. Steward incorrectly asserts that my model does not account for the driving population.[3]

- Dr. Steward also incorrectly asserts that I use the share of residents in each census tract that are Black as a measure of the share of drivers in each census tract who are Black.[4] This reflects a misunderstanding of my model. As I explain below, the control variable for race in my model is included as a way to test whether roadblocks are more frequent in areas of Madison County with a higher fraction of Black residents, controlling for the level of risky driving behavior of the *motorists* in those areas. As I understand it, a central claim in this case is that residents in predominantly Black areas of Madison County claim that roadblocks and other policing activity disrupt their daily lives. The purpose of my model is to assess whether the frequency of roadblocks are more common in areas that have a higher share of Black residents after controlling for the relevant driving behavior of motorists. As I discuss below, this general modeling approach has been published in peer-reviewed journals in the academic literature to assess whether policing activity differs across neighborhoods with a higher share of Black residents, after controlling for relevant crime behavior. It has also been relied on by Courts. More generally, the type of regression model I use in my analysis is a fundamental tool in economics, and a widely accepted tool for examining claims of racial disparities in a wide variety of settings (e.g., crime, hiring/pay, poverty and employment outcomes, and housing market redlining).

- Dr. Steward also makes a basic arithmetic error when interpreting the size of the coefficient on race in my model. This error leads him to substantially understate the relationship between roadblock frequency and the share of the population that is Black across census tracts.

- Dr. Steward also claims that analyzing outcomes at the census tract level "undercuts reliability" and is not standard methodology.[5] This is, again, untrue. Regression analyses that compare outcomes across geographic areas (like census tracts, counties, cities, states, etc.) have been widely

[3] Steward Report, ¶¶ 47–48.

[4] Steward Report, ¶ 36.

[5] Steward Report, ¶ 46.

published in top academic journals, accepted by the Courts, and used to assess a wide variety of questions related to race, discrimination, public policy, and crime. Dr. Steward himself has used such methods as an expert, applying them to even larger geographic areas than census tracts. My use of census tract-level data is appropriate and reliable.

- Finally, Dr. Steward misrepresents and misunderstands the purpose of the descriptive statistics presented in my first report, asserting that I did not perform a test for statistical significance and that my results somehow depend on there being a specific racial threshold for alleged bias.[6] This is untrue. The summary of descriptive statistics presented in my first report is designed to provide an overview of relevant patterns in how the racial population varies across areas of Madison County. As detailed below, starting an analysis with a descriptive summary of key variables is standard practice in peer-reviewed articles that use regression models. As I explained in my initial report, in order to do a proper statistical test of differences in roadblocks across census tracts with different racial breakdowns, a regression model is required. I present a series of regression models that offer such tests in my original report, and that impose *no assumption* on which census tracts have a high or low share of Black residents. The claim that I have not done a proper statistical test is incorrect.

3. In Section 3 of my report, I address the claims that Dr. Steward and Mr. Funderburk raise about the roadblock data. I make several points in that section:

- First, the fact that the data on roadblock location provided by MCSD includes the location of the intersection, rather than an exact address, is not by itself a problem for my analysis. The purpose of my analysis is to look at the frequency of roadblocks across census tracts. As Mr. Funderburk's own analysis shows, the vast majority of intersections in the MCSD data can be cleanly delineated into individual census tracts.[7] As noted above, it is common in academic research to analyze patterns across different geographic units, like census tracts.

[6] Steward Report, ¶ 64–65.

[7] Expert Report of William R. Funderburk, May 8, 2018 ("Funderburk Report"), ¶ 57.

- Second, while Dr. Steward and Mr. Funderburk are correct that some roadblocks are located on the boundary of various census tracts, this fact does not render my analysis unreliable. Such measurement imperfections are a standard part of statistical and economics analysis, and are common in numerous published academic papers that analyze differences across geographic units in various outcomes using regression models. As I explain below, this common feature of data and regression analysis reflects one of the more basis econometric issues discussed in econometrics textbooks (known as "measurement error"), and is understood to typically make an analysis like mine *conservative* because it makes it *less likely* (not more) to find a statistically significant coefficient on the race variable. Further, it is well recognized that there are ways to test whether such measurement error would, in fact, bias my analysis and generate unreliable conclusions. Dr. Steward and Mr. Funderburk do not attempt to answer this question in any way.

- As I show below, when I use standard sensitivity analyses accepted in the academic literature, I show that my findings are unchanged. For example, as I show in Section 3, when my analysis focuses only on roadblocks not near the boundary, my main findings are unchanged. In fact, even if I assume that all of the roadblocks on a boundary occurred in the bordering census tract with the highest white population, my results hold. These tests demonstrate that the higher frequency of roadblocks in census tracts with a higher share of Black residents, found in my original analysis, is not a result of the roadblocks on the boundary between census tracts. Critically, neither Dr. Steward nor Mr. Funderburk offer any analysis to show that the location of certain roadblocks near census tract boundaries affect or change my results in any way.

2. DR. STEWARD MISUNDERSTANDS KEY FEATURES OF MY ANALSYIS, WHICH IS BASED ON METHODS WIDELY USED IN THE ACADEMIC LITERATURE

4. Dr. Steward fundamentally misunderstands the logic of my statistical analysis. Dr. Steward's claims about my model can be grouped into several broad categories, each of which I address in this section.

2.1. My model controls for relevant driving behavior of motorists in census tracts

5. Multiple times in his report, Dr. Steward emphasizes the importance of controlling for the "driving population" on the road when building a statistical model of roadblock frequency.[8] Dr. Steward and I are in agreement on this point – any analysis of roadblock placement must account for the driving behavior of the drivers in the area where roadblocks occur. Where Dr. Steward and I disagree is his claim that my statistical model somehow does not account for the driving population of motorists in Madison County relevant for determining roadblock placement.[9]

6. As I detail in my first report, the most important control variables in my model are the frequency of DUIs and traffic violations of drivers in each census tract. These variables are direct measures of the behavior of motorists in each census tract in Madison County. Indeed, in my initial report I explicitly discuss the importance of controlling for driving behavior and cite to the relevant literature.

> "There is also a body of research literature focused on the specific question of differential policing and policing outcomes across race. That literature also emphasizes the importance of controlling for relevant, non-race factors when assessing claims of racial profiling or bias by police. For example, one study funded by the U.S. Department of Justice to help law enforcement officials and researchers better understand how to analyze data on race and vehicle stops notes 'the strongest research methodologies will address the alternative hypothesis that racial/ethnic groups are not equivalent in the nature and extent of their traffic law-violating behavior.'
>
> Another paper, which summarizes common statistical methods used for analyzing policing data, discusses the importance of controlling for "driving behavior that may be important sources for police decision-making, such as the likelihood of speeding, weaving through traffic, and driving slower than usual," when analyzing traffic violations across race."[10]

[8] Steward Report, ¶¶ 36–39; 45–47.

[9] Steward Report, ¶¶ 47–53.

[10] Expert Report of Bryan Ricchetti, Ph.D., March 13, 2018 ("Ricchetti Report"), ¶¶ 18–20.

7. Despite the fact that I discussed these issues in my report and include in my model multiple measures of driving behavior (and explicitly discuss how those measures are the strongest variables in my model), Dr. Steward asserts that my model relies only on information about the "residential population" in each census tract.[11] As demonstrated above, this claim by Dr. Steward is simply untrue. The central control variable in my model is the frequency of DUIs of motorists in each census tract, which Dr. Steward acknowledges in his own report is "the key factor" in roadblock placement.[12]

8. In addition to directly controlling for the relevant driving behavior of motorists that give rise to roadblocks, I also include several control variables related to the population of residents in each census tract. As I explain in my report, I include these controls ***in addition to*** direct controls for motorists for two main reasons. One is to account for MCSD's claim that the need for their policing resources varies across the county depending on the economic resources of the local police department.[13] These variables are, thus, important to the model. Dr. Steward ignores my explanation of this issue. The second is to add *incremental* information to the model beyond direct measures of motorist behavior. This also consists of two variables – vehicle ownership and age – which, as noted in my first report, are understood to be correlated with driving behavior.[14]

9. As I explain more below in Section 2.4, the approach of using variables that control *both* for direct measures of crime occurring in a neighborhood and for the neighborhood characteristics is used in the academic literature. Further, as I show below in Section 2.5, even if I were to take Dr. Steward's concerns at face value and exclude from my model information predictors about the driving behavior of *residents* in the neighborhood, the results of my model hold. It is notable that

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[11] Steward Report, ¶ 36.

[12] Steward Report, ¶ 54.

[13] Answer and Affirmative Defenses of Defendants, Madison County, Mississippi and Sheriff Randall C. Tucker, In His Official Capacity, *Latoya Brown; Lawrence Blackmon; Herbert Anthony Green; Khadafy Manning; Quinnetta Manning; Marvin McField; Nicholas Singleton; Steven Smith; Bessie Thomas; and Betty Jean Williams Tucker, individually and on Behalf of a class of all others similarly situated, v. Madison County, Mississippi; Sheriff Randall S. Tucker, in his official capacity; and Madison County Sheriff's Deputies John Does #1 through #6, in their individual capacities*, CIVIL ACTION NO. 3:17-cv-347 WHB LRA, dated June 29, 2017, ¶¶ 9, 62.

[14] Fridell, Lorie, "By The Numbers: A Guide for Analyzing Race Data from Vehicle Stops," Police Executive Research Forum, pp. 79–82.

while Dr. Steward claims that the use of these variables in my report is a major problem, he does not offer any analysis or test to show that they affect my ultimate conclusions. As I note throughout this report, this is a common theme with his criticisms.

10. A related argument that Dr. Steward makes is that because my model does not include measures of bars or restaurants it cannot reliably control for risky driving behavior in each census tract.[15] This argument again appears to misunderstand how the control variables in my model work. As noted above, Dr. Steward acknowledges that DUIs are "the key factor" in roadblock placement.[16] Indeed, as Dr. Steward explains in his own report, the main reason one would want to control for the number of bars and restaurants in an analysis of roadblocks is because drunk driving and/or risky driving is more likely to occur in such areas. However, because my model already includes *direct controls* for drunk driving and traffic violations, adding in indirect measures for drunk driving (like concentration of bars and restaurants) would not be expected change the findings of the model because my model already accounts for these factors through DUIs. I discuss this issue further in Section 2.5 below.

11. In an attempt to support this claim that controlling for bars is important, Dr. Steward runs a version of my model in which he adds controls for boating areas and bars, and asserts that after making this change my model does not find a statistically significant relationship between the share of population that is Black and the frequency of roadblock.[17] However, as I explain below, Dr. Steward's analysis is flawed for at least two reasons, and when the flaws are corrected Dr. Steward's own analysis finds the same results as mine. It shows that even when you control for his measures of boating areas and bars the statistically significant relationship between the share of population that is Black and the frequency of roadblocks remains.

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[15] Steward Report, ¶¶ 49–50.

[16] See, for example, Steward Report, ¶ 11 ("… DUI activity and not race, is the key factor in MCSD traffic roadblock location placement."); Steward Report, ¶ 58 ("It my understanding that MCSD receives grant funding from Mississippi Office of Highway Safety (MOHS) in its efforts to reduce the incidents of drunk driving and to assist with cost of establishing DUI traffic roadblocks. It is my understanding that the grant funding is subject to periodic renewal and is contingent on satisfactory achievement of DUI enforcement. Even a cursory look at the traffic roadblock and CAD data shows that the DUI activity in a geographical area during a specific time period is correlated with an increased number of traffic roadblocks in the geographical area in later time periods.").

[17] Steward Report, ¶ 75.

12. First, it is important to understand that Dr. Steward does not in fact include direct controls for the number of bars or restaurants in his model. Instead, he includes a set of "dummy" variables for certain census tracts that he asserts have relatively high or low density of bars. Such a methodology is less precise than using direct measures of DUIs because it cannot distinguish between the level of intensity of bars and/or unsafe driving across census tracts. It instead assumes there are only three types of areas – high, low, and normal.

13. Second, the only reason Dr. Steward finds a statistically insignificant relationship between the population that is Black and the frequency of roadblocks is because he throws out 80 percent of the data when he runs his analysis. Specifically, instead of running his sensitivity analysis on the full six years of data used in my analysis (126 data points), Dr. Steward runs a separate regression for each year from 2012-2017, each of which has only 21 data points.[18] When I simply re-run his model using the full dataset I used in my analysis – including his controls for bars or boating areas – his model finds a ***statistically significant*** relationship between the share of the population that is Black and the frequency of roadblocks that is slightly *larger* in magnitude than my model.[19] Similarly, if I simply take the average effect from his six regressions across all six years, it is also larger in magnitude than the effect in my model.

14. For example, in my original model, I find that the coefficient on the share of Black residents is 0.06218, which translates into 112 more roadblocks over the 6 years of data in a census tract that is 80% Black relative to one that is 20%.[20] Dr. Steward's analysis yields a coefficient of 0.06565 averaged across all six years, which translates into 118 more roadblocks in a census tract that is 80% Black relative to one that is 20%.[21] In other words, Dr. Steward's analysis does not provide any evidence that accounting for bars or boating areas reduces the

[18] Ricchetti Report, Exhibit 6 has 126 data points. As this is estimated over a six year period, a single year has 21 points.

[19] See workpaper. The coefficient on the share of the population that is Black in Dr. Steward's model (which controls for bar and boating areas) is 0.06268 when all data are included in the regression. In my original model, the coefficient is 0.06218.

[20] Ricchetti Report, ¶ 46.

[21] See workpaper.

magnitude of the effect of race; Dr. Steward simply conducts an analysis with fewer data points that reduces the statistical power of the sample.

15. Finally, Dr. Steward claims my model suffers from something called simultaneity bias, because DUIs and roadblocks may be determined at the same time.[22] As I discuss below, a common way to test for this concern in the academic literature is to use DUIs from the prior year as a control variable (referred to as a "lagged" variable in the literature).[23] The logic of this approach is straightforward – DUIs from the prior year are known at the time roadblocks in the current year are set up, whereas roadblocks from the current year cannot deter DUIs from the prior year. As shown in Exhibit 2, when I do this, my results continue to hold. This is another example of Dr. Steward claiming my model has a shortcoming that it does not have, without running any tests.[24]

2.2. The role of the race variable in my model

16. Dr. Steward also incorrectly asserts multiple times in his report that my analysis uses the share of *residents* in a census tract who are Black as a substitute/proxy/replacement for the share of drivers on the road who are Black. As I explain here, my model makes no such assumption.

17. The purpose of including race in my model is to assess whether roadblocks are used more frequently in areas of the county that have a higher share of Black residents, after controlling for the driving behavior (e.g., DUIs) that are the main factor for roadblock placement. As I understand it, Plaintiffs claim in this case, among other things, that the MCSD disproportionately establishes roadblocks in particular residential neighborhoods, including in locations such as the entrances and exits of majority–Black housing complexes. Thus, I understand that a relevant

[22] Steward Report, ¶ 74 (footnote 32).

[23] Fagan, Jeffrey, et al., "Street Stops and Broken Windows Revisited: The Demography and Logic of Proactive Policing in a Safe and Changing City," Stephen K. Rice, and Michael D. White, (Eds.), *Race, Ethnicity, and Policing: New and Essential Readings*, New York University Press, New York and London, 2009, pp. 319–320. "First, in the figures, we use reported homicides in the police precinct in the preceding year as the measure of crime. This lagged function allows us to avoid simultaneity concerns from using contemporaneous measures of crime and police actions."

[24] It is worth pointing out that even if one is concerned about potential simultaneity bias, it could actually cut in the opposite direction Dr. Steward claims, and make my analysis conservative. In particular, to the extent it is true that there is a higher roadblock presence in Black census tracts, this will cause a reporting difference in DUIs between different census tracts. That is, DUIs in white census tracts will be less likely to be caught. This would actually cause my analysis to under-estimate the relationship between the share of Black residents in a census tract and the frequency of roadblocks (relative to DUIs in those census tracts) because the model is missing relatively more information on DUIs in census tracts with a higher white population.

question is whether there are more/fewer roadblocks in certain areas of town than would otherwise be expected given the behavior of motorists in those areas.

18. As I explained previously, my model controls for the different driving behavior of *motorists* across census tracts using the DUI variable discussed above, and then asks the question: Given the differences in motorists' behavior, are roadblocks more frequent in areas with different racial populations? I am not in any way using the racial breakdown of residents as a proxy for the racial breakdown of motorists. I am instead using the racial breakdown of residents as a way to assess whether roadblocks are more or less frequent across different parts of Madison County, controlling for driving behavior.

19. Importantly, as I explain in the next section, the general statistical methodology of examining whether policing activities vary with the racial breakdown of a community (after controlling for relevant measures of crime in that community) has been used in published academic papers and accepted by the Courts.

20. In a somewhat related point, Dr. Steward also criticizes the fact that I normalize roadblocks and DUI's by population.[25] As noted above, because of the nature of the claims in this case, the number of roadblocks per person in different neighborhoods is an appropriate way to measure of any potential impact on residents. Additionally, as I discuss more below, peer-reviewed papers have used residential population in conjunction with direct measures of crime behavior.

21. Further, as with many of his other claims, Dr. Steward does not perform any tests to show that my use of population to normalize roadblocks has any effect on my analysis. I have. Specifically, to test whether Dr. Steward's criticism has merit, I have re-run my model without normalizing roadblocks, DUIs, and traffic violations by population. My main results are unchanged. See Exhibits 3 and 4 Appendix C. Again, Dr. Steward's criticism of my model without running even a very basic statistical test of whether the criticism affects my results is not the accepted method for analyzing whether a model's findings are sensitive to the

[25] Many of Dr. Steward's criticisms focus on the total number of roadblocks, rather than the number of roadblocks per 1,000 people in a census tract, as I focus on in my model. See, for example, Steward Report, ¶¶ 17, 37.

control variables included. If a researcher is concerned that a particular variable (or feature of a model) creates bias in an analysis, they can directly test their concern using sensitivity analysis.[26] Dr. Steward does not do this.

2.3. Dr. Steward misinterprets the size of the race coefficient in my model

22. Dr. Steward also presents the rather unorthodox argument that, even though the race variable in my model is statistically significant, the fact that it is smaller in magnitude than the DUI variable means that race is not relevant. In making this argument, Dr. Steward makes several basic interpretation errors, which lead him to both incorrectly calculate the effect that race has on the number of roadblocks, and incorrectly compare the relative impacts of race and DUIs on roadblock placement.

23. For example, Dr. Steward says, "if the African-American population of a census tract increased by 1% per year, then there would be 0.06 more roadblocks in that tract per year…it would take approximately sixteen (16) years for there to be an additional roadblock in that given tract."[27] Dr. Steward's statement includes several basic errors (both in interpretation and mathematical) that render it inaccurate.

24. First, Dr. Steward does not account for the fact that my model normalizes variables (including roadblocks, the outcome variable of my model) by population.[28] This means that my coefficient does not show the effect of race on total roadblocks, it shows the effect of race on roadblocks for every 1,000 residents. Given that the average census tract in Madison County has 5,000

[26] Wooldridge, Jeffrey M., *Introductory Econometrics: A Modern Approach*, 5th Edition, South-Western Cengage Learning, Mason, Ohio, 2012, pp. 684-685. ("If your model has some potential misspecification, such as omitted variables, and you use OLS, you should attempt some sort of misspecification analysis of the kinds we discussed in Chapters 3 and 5. Can you determine, based on reasonable assumptions, the direction of any bias in the estimators?... Good papers in the empirical social sciences contain sensitivity analysis. Broadly, this means you estimate your original model and modify it in ways that seem reasonable. Hopefully, the important conclusions do not change.").

[27] Steward Report, ¶56.

[28] In deposition testimony, Dr. Steward stated that the roadblock variable in my model is the total number of roadblocks, rather than the number per 1,000 residents. This is incorrect, and was explained in my original report. See Deposition of Dwight Steward, Ph.D., June 22, 2018 ("Steward Deposition"), p. 256:6–12.

residents, Dr. Steward understates the effect of his example by a factor of 5.[29] Second, as I describe in my first report, the proper way to interpret my coefficient is to consider two census tracts with different shares of Black residents over the 6 years of data.[30] Dr. Steward's thought experiment, which considers how a census tract's race share might change over time, ignores the large variation in the Black share of the population which already exists across census tracts.

25. As is clearly explained in my original report, my model predicts that over a 6 year period there would be 112 roadblocks more in a census track that is 80% Black compared to one that is 20% Black, even after controlling for DUIs.

> "The following example helps explain what the coefficient signifies. Suppose that we compare an area that was 20% Black to one that was 80% Black. The coefficient means that there would be 3.73 more roadblocks per 1,000 citizens on average in the area that was 80% Black.[31] To put that into context, the average census tract in Madison County had about 5,000 people per year during the relevant period. For such an average census tract, if the percentage of Black residents is 80% instead of 20%, my model predicts that there will be over 18 more roadblocks per year (3.73 more roadblocks per 1,000 people is 18.65 total roadblocks), or about 112 more roadblocks in total over the 6 years of data I analyze."[32]

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[29] Dr. Steward makes another, unrelated, math error in the example he presents. He describes a census tract where the share of the population that is Black grows by one percentage point per year. To calculate the expected time it would take to generate an additional roadblock he erroneously divides 1 by 0.06, the effect of a one-point increase in the Black population. This calculation actually provides the length of time it would take to generate an extra roadblock per 1,000 people if the Black population increased by one point, once, and then remained at that level for 16 years (e.g. if the Black population increased from 50 to 51 percent and remained at 51 percent). If the Black population increased one point *each year*, as Dr. Steward describes in his example, the first year would have 0.06 additional roadblocks per 1,000 people. However, in the second year, the Black population would increase by an additional percentage point and would be two percentage points higher than in the base year resulting in approximately 0.06 x 2 = 0.12 roadblocks per 1,000 people in the second year alone. The result over 16 years would be more than 8 additional roadblocks per 1,000 people. The estimated coefficient suggests an average census tract, with a population of 5,000, would experience an increase of over 42 roadblocks over the 16-year period, not one roadblock as Dr. Steward claims. See workpaper.

[30] Ricchetti Report, ¶¶ 33, 46.

[31] The effect of moving from an area that was 20% Black to one that was 80% Black in my model is equal to (80-20)*0.06218, which equals 3.7308.

[32] Ricchetti Report, ¶ 46.

26. Third, Dr. Steward's errors in interpreting the race coefficient also lead him to make the erroneous statement that the effect of DUIs is 20 times greater than that of race.[33] When comparing the relative magnitude of two distinct coefficients, it is well recognized that it is important to make an "apples to apples" comparison in terms of units and effect size. The racial breakdown of the population and the number of DUIs per 1,000 people operate on different scales, and have very different underlying characteristics. A common approach for doing this is to ask what is the effect of changing different factors by one standard deviation. When I do this basic scaling exercise, the effect of DUIs is not 20 times greater – it is about 2 times greater.[34] Another related measure, which is favored by economists for being "unitless" – that is, for allowing natural comparisons across different types of different variables, regardless of their scales, is called "elasticity." When I compare the elasticities of DUIs and race in my model of roadblock placement, the effect of DUIs is only 1.16 times greater.[35]

27. Finally, Dr. Steward does not offer an explanation or citation for his apparent contention that only the single variable that is the greatest in magnitude can have explanatory significance.[36] As I explain below, the purpose of a model like mine is to test whether race has a significant effect after accounting for non-race factors that might affect roadblocks. This is a common methodology in academic papers assessing racial disparities in outcomes. Dr. Steward's contention is similar to saying that because income is a well-known factor than can explain lending rates, race cannot be a significant factor as well. There is nothing to prevent both from being true, and any such claim would stand in direct contrast to the literature.[37]

2.4. The general methodology I use has been used in published papers studying racial profiling, and in papers studying discrimination more generally

28. In an attempt to support his claims that my model is flawed, Dr. Steward asserts that my methodology is not used in the literature on policing and crime.[38]

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[33] Steward Report, ¶ 20.

[34] See workpaper.

[35] See workpaper.

[36] The supporting analysis Dr. Steward appears to offer on this point is at ¶¶ 59–61 of his report. There Dr. Steward presents analysis showing a relationship between roadblocks and DUIs. Such a relationship, however, does not preclude the possibility of an effect of the share of population that is Black on roadblock frequency, controlling for DUIs.

[37] Rougeau, Vincent D. and Keith N. Hylton, "Lending Discrimination: Economic Theory, Econometric Evidence, and the Community Reinvestment Act," *The Georgetown Law Journal*, 85(237), 1996, p. 290.

[38] Steward Report, ¶¶ 38–39.

Dr. Steward makes a few claims about how and why my model purportedly does not fit into the academic literature. I address these claims below, and show that they are inconsistent with the literature.

2.4.1. The model I use has been used in the academic literature and accepted by Courts

29. First, Dr. Steward suggests that analyzing differences in crime across neighborhoods with different racial breakdowns is somehow non-standard or not accepted.[39] This claim is simply untrue.

30. A leading example of this methodology can be seen in a set of papers by Prof. Jeffrey Fagan of Columbia University and his co-authors that analyze whether New York City's "Stop, Question, and Frisk" program ("SQF") was used more heavily in minority neighborhoods.[40] In two different papers, Prof. Fagan and his co-authors build a statistical model of the frequency and location of the SQF program that has the same general methodological structure as my model of the frequency and location of roadblocks. Specifically, they include counts of SQF encounters at the precinct level as their dependent variable (just as the dependent variable in my model is counts of roadblocks at the census tract level). They then include controls for the direct measures of crime that SQF seeks to regulate (just as I include controls for the frequency of DUI and traffic violations variables). Further, they also include controls for certain characteristics of neighborhood *residents* (just as I do). Finally their main variable of interest is a variable measuring the share of Black residents in a given precinct and, just as in my model, they examine whether the coefficient on the share of Black residents is statistically significant, after controlling for crime in the neighborhood.[41] In

[39] Steward Report, ¶ 47.

[40] Fagan, Jeffrey. et al., "Street Stops and Broken Windows Revisited: The Demography and Logic of Proactive Policing in a Safe and Changing City," Stephen K. Rice, and Michael D. White, (Eds.), *Race, Ethnicity, and Policing: New and Essential Readings*, New York University Press, New York and London, 2009, pp. 309–348; Gelman, Andrew et al., "An Analysis of the New York City Police Department's 'Stop-and-Frisk' Policy in the Context of Claims of Racial Bias," *Journal of American Statistical Association*, 109(479), pp. 813–823. One of Fagan's co-authors in this work is Andrew Gelman, one of the preeminent statisticians in the field, who has received the Outstanding Statistical Application award from the American Statistical Association (the award for best article published in the American Political Science Review) and the Council of Presidents of Statistical Societies award for outstanding contributions by a person under the age of 40.

[41] It is worth noting that rather than normalizing their variables by population and using an OLS regression, Prof. Fagan and his colleagues include population as a control variable and use a Poisson regression. These two approaches are

addition to being published in academic journals, Prof. Fagan's model was relied on by Courts in *Floyd et al. v. the City of New York*, including specifically his analysis of how SQF varied with the share of residents who were Black.[42]

31. This same methodological approach has been used in published academic papers to examine how a variety of different economic outcomes differ between neighborhoods with different racial compositions, while controlling for relevant non-race factors that affect the outcomes of interest. For example, empirical research on the possibility of "redlining" (i.e., banks offering different terms on mortgages in Black neighborhoods, even after controlling for non-race factors) uses the same statistical model to assess how lending in different neighborhoods vary with the population of the neighborhood that is Black, controlling for other factors.[43] There is also a literature that examines how the racial composition of different neighborhoods affects schooling and employment outcomes, including papers by top economists like David Card, Ed Glaeser, Raj Chetty, and Larry Katz in top peer-reviewed journals.[44] These papers also use the same general statistical approach of comparing outcomes across geographic areas with different racial compositions.

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closely related, as they both control for population – they simply use a slightly different approach. As shown in Exhibit 4, I have run my model using a Poisson regression as Prof. Fagan does, and it yields the same conclusion as my model.

[42] Opinion and Order, Floyd et al. v. the City of New York, 5/16/2012, pp. 6–7.

[43] Rougeau, Vincent D. and Keith N. Hylton, "Lending Discrimination: Economic Theory, Econometric Evidence, and the Community Reinvestment Act," *The Georgetown Law Journal*, 85(237), 1996, pp. 237–292, 269–270 ("The studies we will examine use regression analysis to test for discrimination in lending. This is the most powerful method of testing for discrimination in a sample of lending decisions, because it allows the researcher to isolate the influence of each factor on the decision to lend. A typical regression model might specify the total dollar amount of residential loans in a geographic market as a linear function of several variables, such as the average income of residents and the percentage of minority residents. Thus, if L = total loans in neighborhood j (j = 1, ... N, where N is the number of neighborhoods), I = average income in neighborhood j, and R = percentage of minority residents in neighborhood j, a regression model would specify L = b1l + b2R + e, where b, and b2 are coefficients and e is a random error. If the coefficient on R, b2, is negative and statistically significant, then the data indicate that if one holds fixed the level of average neighborhood income, neighborhoods with high minority percentages receive less credit. If one believes that average neighborhood income should account for differences in the level of total lending to communities, with the combination of other influences having an essentially random influence, then this would be taken as evidence of discrimination.").

[44] See for example, Card, David and Jesse Rothstein, "Racial Segregation and the Black-White Test Score Gap," *Journal of Public Economics*, 91(11 - 12), 2007, pp. 2158 - 2184; Cutler, David M. and Edward L. Glaeser, "Are Ghettos Good or Bad?" *Quarterly Journal of Economics*, 112(3), 1997, pp. 827–872; and Chetty, Raj, Nathaniel Hendren, and Lawrence F. Katz, "The Effects of Exposure to Better Neighborhoods on Children: New Evidence from the Moving to Opportunity Experiment," *American Economic Review*, 106(4), 2016, pp. 855–902. All three papers use census tracts.

32. More generally, as I explained in my first report, the type of multiple regression analysis I use in my analysis that attempts to isolate the effect of race separately from non-race factors is a widely accepted and common statistical technique in both academia and litigation for assessing the possibility of discrimination in a variety of settings (e.g., hiring, wages, and mortgage lending).[45] Courts have relied on multiple regression analysis in a variety of discrimination matters. For example, the Federal Judicial Center's *Reference Manual for Scientific Evidence* (a document designed to aid federal judges in assessing scientific evidence) dedicates an entire chapter to multiple regression analysis, including applications to questions of discrimination.[46] Regression analysis is a useful tool to assess claims of discrimination precisely because it allows a researcher to control for relevant factors in the available data that affect the outcome of interest (e.g., the behavior of motorists) in order to more reliably isolate the effect of the variable on which there is alleged discrimination (e.g., race, gender, age).

33. In sum, the type of regression analysis I use in my report has (a) been used in academic papers to directly test whether policing differs with the residential population of different neighborhoods (after controlling for crime), (b) been used in a wide variety of academic papers analyzing questions of race and other economic outcomes, and (c) been relied on by Courts in cases involving claims of discrimination in a variety of contexts.

2.4.2. Use of census tract data, and other geographic data, is standard in the academic literature

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[45] Rubinfeld, Daniel L., "Reference Guide on Multiple Regression," *Reference Manual on Scientific Evidence*, 3rd Edition, Federal Judicial Center, the National Academies Press, Washington, D.C., 2011, pp. 312–317; Altonji, Joseph G., and Rebecca M. Blank, "Race and Gender in the Labor Market," Ashenfelter, Orley David C., Card, (Eds.), *Handbook of Labor Economics*, 3, 1999; Blau, Francine D., and Lawrence M. Kahn, "Gender Differences in Pay," *Journal of Economic Perspectives*, 14(4), 2000, pp. 75–99; Rougeau, Vincent D. and Keith N. Hylton, "Lending Discrimination: Economic Theory, Econometric Evidence, and the Community Reinvestment Act," *The Georgetown Law Journal*, 85(237), 1996, pp. 237–294, 269-270.

[46] Rubinfeld, Daniel L., "Reference Guide on Multiple Regression," *Reference Manual on Scientific Evidence*, 3rd Edition, Federal Judicial Center, the National Academies Press, Washington, D.C., 2011, pp. 305–307 ("Regression analysis has been used most frequently in cases of sex and race discrimination, antitrust violations, and cases involving class certification.").

34. In addition to arguing that my use of racial breakdown of residents at the census tract-level is not accepted methodology, Dr. Steward also claims that the fact that my analysis is conducted at the census tract level is problematic. One reason for this critique is that the racial distribution *within a census* tract can vary.[47] This critique by Dr. Steward is at odds with the large literature in economics that routinely analyzes data across different geographic units to measure the correlations of key variables. This type of analysis is a widely accepted methodology for understanding why different neighborhoods, cities, states, and/or regions have different outcomes and experiences. As one widely used textbook notes, "Often the data used in empirical economics are at the city or county level."[48]

35. This literature includes numerous analyses of crime and policing across geographic areas. For example, as already discussed above, Prof. Fagan's work has this feature. More generally, there is a large body of academic research that uses differences in crime activity and policing activity across different geographical units (cities, counties, etc.) to understand the relationships between crime, policing and other variables.[49] In fact, I understand Dr. Steward himself has conducted analysis across much larger geographic regions in prior expert work on crime and race.[50]

36. The use of census tracts in particular is also accepted in the literature. A variety of published papers in top journals leverage census tract data to analyze how different economic outcomes vary across neighborhoods based on the racial composition of those neighborhoods, and other socioeconomic factors.[51] This research includes several papers analyzing an intervention called the MTO (Moving to Opportunity) program conducted by the U.S. Department of Housing and Urban Development, which moved a set of children from relatively high

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[47] Steward Report, ¶¶ 43–46.

[48] Wooldridge, Jeffrey M., *Introductory Econometrics: A Modern Approach*, 5th Edition, South-Western Cengage Learning, Mason, Ohio, 2012, p. 689.

[49] Chalfin, Aaron, and Justin McCrary, "Criminal Deterrence: A Review of the Literature," *Journal of Economic Literature*, 55(1), 2017, pp 5–48, offers a summary of the literature. See also the Rebuttal Expert Report of Justin McCrary, Ph.D., July 2, 2018 ("McCrary Report")

[50] Opposition to Defendants' Joint Motion to Exclude Dwight Steward, Ph.D., as an Expert Witness, *Kelly v. Paschall*, February 24, 2005.

[51] See for example, Card, David and Jesse Rothstein, "Racial Segregation and the Black-White Test Score Gap," *Journal of Public Economics*, 91(11–12), 2007, pp. 2158–2184; Cutler, David M. and Edward L. Glaeser, "Are Ghettos Good or Bad?" *Quarterly Journal of Economics*, 112(3), 1997, pp. 827–872; and Chetty, Raj, Nathaniel Hendren, and Lawrence F. Katz, "The Effects of Exposure to Better Neighborhoods on Children: New Evidence from the Moving to Opportunity Experiment," *American Economic Review*, 106(4), 2016, pp. 855–902.

poverty neighborhoods to relatively low poverty neighborhoods, and then tracked their successes over time relative to a control group that did not move. This study identified high poverty neighborhoods with census tracts.

37. All of the papers discussed above have the same feature in their data that Dr. Steward criticizes in my analysis. They include variables that are measured across geographic units, such as census tract, county, city-level, etc., and those variables have values that vary across sub-areas of whatever geographic unit is being analyzed. Yet all of these papers are published in peer-reviewed journals. It is well understood in the academic literature that this type of data introduces a type of white noise, which is commonly referred to as measurement error. This feature of the data is understood to, if anything, make it *more difficult* to find a statistically significant correlation, as the additional noise tends to attenuate the estimated statistical relationship between difference variables. In Section 3 below, I discuss this issue in more detail.

38. Dr. Steward's claim that this issue makes my analysis unreliable is, thus, inconsistent with basic econometric principles and inconsistent with accepted practice in the scientific literature.

2.5. Dr. Steward overstates the role of factors not included in my model

39. Dr. Steward also argues that unobserved factors not included in my model could explain the estimated effect that the model currently attributes to the racial composition of the census tract. Dr. Steward alleges that I did not consider standard approaches to test the potential effects of omitted factors.[52] There are a few points worth noting here.

40. As discussed in my first report, it is widely recognized that R-Squared is a statistic that helps measure how well the control variables in the regression model explain the frequency of roadblocks across the different census tracts. [53] The R-

[52] Steward Report, ¶¶ 74–75.

[53] Rubinfeld, Daniel L., "Reference Guide on Multiple Regression," *Reference Manual on Scientific Evidence*, 3rd Edition, Federal Judicial Center, the National Academies Press, Washington, D.C., 2011, p. 316 ("In general, the more complete the explained relationship between the included explanatory variables and the dependent variable, the more precise the results.").

Squared of 0.65 in my model is considered to be a large R-Squared. For example, as I noted in my first report, one popular econometrics textbook states that, "in terms of the values one normally encounters in cross sections, an R-Squared of 0.5 is relatively high."[54]

41. Further, a widely accepted practice for testing whether the results of a regression may be sensitive to the addition of omitted variables is to run different sensitivity analyses and assess the overall pattern of the coefficient as more variables are added, and as other changes are made to the model.[55] As detailed in Appendix C Exhibits 1-6 and in my workpapers, I have now run more than 50 sensitivities of my model. Across all such sensitivities, the coefficients are statistically significant and stable. Further, the addition of more variables does not decrease the effect of race.

42. Note that the sensitivity results are unsurprising because we already control for what Dr. Steward agrees is the most important determinant of roadblocks. Adding other factors to the regression should not be expected to change the results once the key factor is considered, and the data bears this out. Indeed, Dr. Steward's own sensitivity analysis in which he adds control variables for bars and restaurants supports this conclusion. As shown above, that model finds that the effect is, if anything, a bit larger in magnitude than my original model.

2.6. Dr. Steward misrepresents my descriptive analysis, and incorrectly claims that I do not perform tests of statistical significance

43. Dr. Steward also criticizes the summary of data that I present in Section 4.1 of my report. Dr. Steward identifies two issues with that analysis, each of which I discuss below. In making these criticisms, Dr. Steward demonstrates a basic misunderstanding of the purpose of summary data.

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[54] Greene, William H., *Econometric Analysis*, 6th Edition, Pearson Prentice Hall, Upper Saddle River, New Jersey, 2008, p. 38.

[55] Oster, Emily, "Unobservable Selection and Coefficient Stability: Theory and Evolution" NBER Working Paper, August 9, 2016, p. 2 ("A common approach in these situations [wherein observed controls are an incomplete proxy for the true omitted variable or variables] is to explore the sensitivity of treatment effects to the inclusion of observed controls. If a coefficient is stable after inclusion of the observed controls, this is taken as a sign that omitted variable bias is limited.").

44. Beginning a statistical analysis with a descriptive overview of the patterns in key variables is standard in academic papers. Indeed, basic statistics and econometrics textbooks note that it is common to start an analysis with a descriptive summary of key variables before developing a formal statistical test.[56] The fact that Dr. Steward focuses much of his criticism on basic descriptive statistics rather than on the formal statistical tests in my regression model is atypical in academic research, as the regression model is the formal statistical method for testing the hypothesis while controlling for other factors.[57]

45. One of Dr. Steward's criticisms is that I did not present a test of statistical significance in that section.[58] This statement suggests that Dr. Steward misunderstands the purpose of the data summary. As I explicitly stated in my initial report, the purpose of the data summary was not to perform a statistical test, but rather to highlight the general patterns in the data. As Dr. Steward himself discusses in his report, it is necessary to control for other factors which can influence roadblock placement prior to testing whether any effect can be attributed to race.[59] As is appropriate and consistent with this standard methodology, I do in fact perform a test of statistical significance in the context of my regression model that controls for driving behavior and other factors. The summary of the data presented in Section 4.1 is meant only to highlight general patterns in the data that inform my regression analysis. In fact, I discussed this issue clearly in my initial report.

> "I start my analysis in Section 4.1 with a set of descriptive analyses that highlight the general patterns in the location and frequency of

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[56] Moore, D., and McCabe, G., *Introduction to the Practice of Statistics*. 5th Edition, W.H. Freeman and Company, New York, 2004, at p. 7 ("Statistical tools and ideas help us examine data in order to describe their main features. This examination is called exploratory data analysis. Like an explorer crossing unknown lands, we want first to simply describe what we see."); See also Kennedy, Peter, *A Guide to Econometrics*, 6th Edition, Blackwell Publishing, 2008, p. 364; Wooldridge, Jeffrey M., *Introductory Econometrics: A Modern Approach*, 5th Edition, South-Western Cengage Learning, Mason, Ohio, 2012, p. 690.

[57] Wooldridge, Jeffrey M., *Introductory Econometrics: A Modern Approach*, 5th Edition, South-Western Cengage Learning, Mason, Ohio, 2012, p. 68 ("Multiple regression analysis…allows us to *explicitly* control for many other factors that simultaneously affect the dependent variable. This is important both for testing economic theories and for evaluating policy effects when we must rely on nonexperimental data. The multiple regression model is still the most widely used vehicle for empirical analysis in economics and other social sciences").

[58] Steward Report, ¶ 64.

[59] Steward Report, ¶ 48.

> roadblocks across the 21 different census tracts in Madison County. I show that the frequency of roadblocks is generally higher in census tracts with a substantially higher percentage of Black residents. In Section 4.2, I then present the findings of my regression analysis, where I formally test whether the frequency of roadblocks is higher in census tracts with a higher percentage of Black residents, controlling for other factors that are predictive of differences in traffic behavior."[60]

46. Dr. Steward also argues that my grouping of the census tracts into two groups (those with a relatively high share of Black residents and those with a relatively low share) somehow makes my analysis unreliable. In fact, Dr. Steward asserts that I assume "racial bias appears when a census tract achieves an African-American population of 46.2%."[61] This argument is incorrect and again misrepresents how my analysis works. While it is true that I group the census tracts into two groups when summarizing the data to highlight the fact that there is large variation in the racial population across the county, in the formal statistical tests that I run using my regression model in Section 4.2, I *do not* group the census tracts in this manner. Thus, none of my conclusions depend in *any way* on the grouping of census tracts that I present as a descriptive device. Further, Dr. Steward's various re-groupings of my descriptive analysis do not in any way rebut (or even address) the findings from my regression analysis, which are the appropriate and rigorous way to test for a general relationship between roadblocks and the racial breakdown across census tracts (controlling for other factors).

3. DR. STEWARD'S ANALYSIS OF THE GEOCODING DATA IGNORES BASIC ECONOMETRIC PRINCIPLES

47. In addition to commenting on my statistical methodology, Dr. Steward (as well as Mr. Funderburk) also makes several claims about the data I use on the location of roadblocks. They point in particular to three facts about the location data produced by MCSD. First, they note that it is common for MCSD to report roadblocks based on intersections rather than exact addresses.[62] Second, they note

[60] Ricchetti Report, ¶¶ 35–36.

[61] Steward Report, ¶ 35.

[62] Steward Report, ¶ 26; Funderburk Report, ¶¶ 22, 44.

that a set of roadblocks were established on the boundaries of census tracts.[63] Third, they note that some of the specific address information produced by MCSD does not line up with physical locations where a roadblock could reasonably occur.[64]

48. In this section, I explain how Dr. Steward's and Mr. Funderburk's critiques of the roadblock data ignore the relevant question from a statistical point of view: do these potential data issues have any meaningful effect on the key findings from my regression analysis? As I explain below, using basic econometric principles of measurement error that I discussed above, there are well-accepted methods for testing this question. Despite these well-accepted methods, neither Dr. Steward nor Mr. Funderburk offer *any tests* to show that the existence of roadblocks on census boundaries affect my conclusions. As I show, when I run such tests I find that my findings are not sensitive to the data issues they describe. Specifically, as I show below, even if we employ a standard technique of removing data points with potential measurement issues, the general findings of my regression model remain unchanged and the precision of my model actually increases – a result that is consistent with the large academic literature on measurement error. In fact, even if I make the assumption that every roadblock on the boundary was in fact set up in the census tract it borders with a relatively *lower share* of Black residents, my regression still finds that roadblock frequency increases in census tracts with a higher share of Black residents.

49. While Mr. Funderburk and Dr. Steward both suggest that this measurement challenge renders my analysis unreliable, it is striking that neither of them offer any statistical test that demonstrates that this measurement challenge affects my results in any meaningful way. As I explain below, making such an argument without running a statistical test for whether it matters is not consistent with standard methods described in econometrics textbooks.[65] Following standard

[63] See for example, Steward Report, ¶¶ 30–31, 41; Funderburk Report, ¶ 48.

[64] See for example, Steward Report, ¶¶ 28–29; Funderburk Report, ¶ 48.

[65] Wooldridge, Jeffrey M., *Introductory Econometrics: A Modern Approach*, 5th Edition, South-Western Cengage Learning, Mason, Ohio, 2012, pp. 684-685. ("If your model has some potential misspecification, such as omitted variables, and you use OLS, you should attempt some sort of misspecification analysis of the kinds we discussed in Chapters 3 and 5. Can you determine, based on reasonable assumptions, the direction of any bias in the estimators…. Good papers in the empirical social sciences contain sensitivity analysis. Broadly, this means you estimate your original model and modify it in ways that seem reasonable. Hopefully, the important conclusions do not change.").

methodological practice, I have tested whether the presence of measurement error biases my conclusions in any way. It does not.

50. Finally, as explained in Dr. Frontiera's report, the geocoding approach used in my first report is a standard approach and consistent with best practices. Additionally, the criticisms of Mr. Funderburk are derived from a non-random sample and caused by poor data quality in the data produced by MCSD, rather than geocoding methods.[66]

3.1. Measurement error is a well-recognized feature of many regression models, and is only a problem if the error is correlated with the variable of interest

51. The main thrust of Mr. Funderburk and Dr. Steward's concern about roadblock data is that some of the roadblocks are near the boundary between two census tracts and may be incorrectly assigned to the wrong census tract based on the information provided in MCSD database.[67] This concern amounts to a very standard methodological issue that is widely studied in econometrics – measurement error.[68]

52. As is well understood in the scientific literature (and discussed in introductory econometrics textbooks), the key question in such a situation is: how does the presence of such noise in the data affect the regression coefficients? This question is one of the most standard methodological questions in econometrics because it is common for data used in social science to be imprecisely measured.

53. For example, one academic paper on empirical methods in econometric analysis, written by Alan Krueger, former Chair of the Counsel of Economic Advisors to the President, and Josh Angrist (MIT) notes that: "[I]t is probably

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[66] Rebuttal Expert Report of Patricia Frontiera, Ph.D., July 2, 2018 ("Frontiera Report"), ¶¶ 9, 61.

[67] Steward Report, ¶¶ 31, 41; Funderburk Report, ¶¶ 16, 51.

[68] It is worth noting that, in his deposition testimony, Dr. Steward did not accurately define measurement error. Dwight Steward Deposition, pp. 186:17–187:7. ("Q. And what is your understanding of that term [measurement error]? A. Measurement error is not data error. Measurement error is a completely statistical term. And again, it has to do with a tool, not with the data. Measurement error just has to do with accounting for the fact that there are going to be some things you can't measure. Like, the classic example is fire in the belly when you're looking at salary. You're going to have some people that just work really hard and other people that don't really hard. But on average, when you're doing a salary analysis, it balances out.")

best to think of data as routinely being mismeasured. Although few economists consider measurement error the most exciting research topic in economics, it can be of much greater practical significance than several hot issues."[69] In fact, the *Reference Manual on Scientific Evidence* – a treatise designed to address methodological issues that arise in expert testimony – also discusses the issue of measurement error, and how to test whether it affects a model's results.[70]

54. Mathematically, measurement error is expressed as follows:

$$Measured\ Roadblocks_i = Roadblocks_i + u_i$$

55. The key parameter in the above equation is u_i, which is referred to as measurement error in the econometrics literature. As explained in econometrics textbooks, in order to understand whether the presence of u_i presents any problems for a regression analysis like mine, the key question is whether u_i is correlated in a very specific way with the race variable in my model. For example, it could be that the existence of u_i causes my model to *understate* the number of roadblocks in census tracts with a high share of Black residents. If that were the case, my model would be conservative. On the other hand, it could be that the existence of u_i causes my model to *overstate* the number of roadblocks in census tracts with a high share of Black residents, which would make my model overstate the correlation between race and roadblocks. There are several key insights in the scientific literature about measurement error that help explain why it does not typically pose a problem for regression analysis.

56. First, when measurement error is generated by data entry issues (i.e., the person entering the data into the database does not enter complete information), typically the measurement error represents nothing more than random noise. In this situation, measurement error ***does not lead to any bias in the regression analysis***. The only effect is to decrease the precision of the regression coefficients, making it *harder* to find a significant effect. For example, a widely used textbook in econometrics describes these issues in the following passage:

[69] Angrist, Joshua D., and Alan B. Krueger, "Empirical Strategies in Labor Economics," Orley C. Ashenfelter and David Card, (Eds.), *Handbook of Labor Economics*, 1999, p. 1340–1341.

[70] Rubinfeld, Daniel L., "Reference Guide on Multiple Regression," *Reference Manual on Scientific Evidence*, 3rd Edition, Federal Judicial Center, the National Academies Press, Washington, D.C., 2011, pp. 327–328.

> "The usual assumption is that the measurement error in [a dependent variable] is statistically independent of each explanatory variable. ***If this is true, then the OLS estimators [the regression coefficients] are unbiased and consistent.*** Further, the usual OLS inference procedures (*t*, *F*, *LM* statistics are valid)… measurement error in the dependent variable results in a larger variance than when no error occurs; this, of course, results in larger variances of the OLS estimators…. The bottom line is that, ***if the measurement error is uncorrelated with the independent variables, then OLS estimation has good properties."*** [71] (emphasis added)

57. Krueger and Angrist describe the issue as follows:

> "What are the implications of classical measurement error?... If Y_i [the dependent variable] is regressed on one or more correctly-measured explanatory variables, the expected value of the coefficient estimates is not affected by the presence of the measurement error. ***Classical measurement error in the dependent variable leads to less precise estimates - because the errors will inflate the standard error of the regression - but does not bias the coefficient estimates."***[72] (emphasis added)

58. Further, when measurement error is present in an independent variable (as Dr. Steward claims of my race variable), ***the main effect of measurement error is attenuate, or shrink, the size of the coefficient of interest***. For example, the *Reference Manual on Scientific Evidence* notes the following:

> "[I]f one or more independent variables are measured with error, the corresponding parameter estimates are likely to be biased, typically toward zero (and other coefficient estimates are likely to be biased as well). To understand why, suppose that the dependent variable, salary, is measured without error, and the explanatory variable, experience, is

[71] Wooldridge, Jeffery M., *Introductory Econometrics: A Modern Approach*, 5th Edition, South-Western Cengage Learning, Mason, Ohio, 2012, pp. 318–319.

[72] Angrist, Joshua D., and Alan B. Krueger, "Empirical Strategies in Labor Economics," Orley C. Ashenfelter and David Card (Eds.), *Handbook of Labor Economics*,, 1999. p. 1340

> subject to measurement error. (Seniority or years of experience should be accurate, but the type of experience is subject to error, because applicants may overstate previous job responsibilities.) As the measurement error increases, the estimated parameter associated with the experience variable will tend toward zero, that is, eventually, there will be no relationship between salary and experience."[73]

59. In other words, the typical effect of the measurement error that Dr. Steward and Mr. Funderburk describe in my analysis is to increase the standard errors of the regression coefficients, making it harder for my analysis to find statistical significance, and, thus, if anything, **shrink** the effect of race, making my analysis more conservative. As I show in the next sub-section, a variety of sensitivity analyses confirm that any imprecision in the measurement of roadblocks per census tract have no effect on my ultimate conclusions.

60. Before moving on to my sensitivity analysis, it is worth noting one other data issue that Mr. Funderburk and Dr. Steward raise. Both point out that many of the roadblocks *not* on the boundary of the census blocks are located at intersections rather than exact addresses.[74] As Dr. Frontiera explains, this data feature is common in geocoding and does not present a problem.[75] As I discuss below, to demonstrate that such concerns are not a problem for my analysis I have also hand-entered each roadblock and tested whether my findings change. They do not.

3.2. When I apply standard sensitivity tests for roadblocks that are near the boundary of census tracts, my findings are unchanged

61. In response to the criticisms of Mr. Funderburk and Dr. Steward, I perform several analyses, which can quantify the implications of their criticisms on my model (notably, Dr. Steward and Mr. Funderburk attempt no such calculations on their own).

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[73] Rubinfeld, Daniel L., "Reference Guide on Multiple Regression," *Reference Manual on Scientific Evidence*, 3rd Edition, Federal Judicial Center, the National Academies Press, Washington, D.C., 2011, pp. 327; See also Angrist, Joshua D., and Alan B. Krueger, "Empirical Strategies in Labor Economics," Orley C. Ashenfelter and David Card (Eds.), Handbook of Labor Economics, 1999. p. 1340.

[74] Steward Report, ¶ 26,; Funderburk Report, ¶¶ 22, 44.

[75] Frontiera Report, ¶¶ 29-31.

62. A standard and well-accepted way to test whether measurement error affects the results of a regression model is to run sensitivity tests of the main model by removing the data points that are likely to have measurement error. For example, the *Reference Manual on Scientific Evidence* notes the following:

> "In general, it is important to explore the reasons for unusual data points. If the source is an error in recording data, the appropriate corrections can be made. If all the unusual data points have certain characteristics in common (e.g., they all are associated with a supervisor who consistently gives high ratings in an equal pay case), the regression model should be modified appropriately. One generally useful diagnostic technique is to determine to what extent the estimated parameter changes as each data point in the regression analysis is dropped from the sample."[76]

63. The literature also refers to this technique as "trimming."[77] One common example of trimming that has been used in the academic literature occurs when economists analyze self-reported income. It is well-known that some subset of people will significantly over-report and/or under-report their income for a variety of reasons. In order to ensure that this type of measurement error does not affect statistical analyses of wages, academics often times remove the highest and lowest wage values from their data because these data points are the ones most likely to have measurement error.[78] Papers have also applied trimming techniques to potential measurement error in geographic boundaries.[79]

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[76] Rubinfeld, Daniel L., "Reference Guide on Multiple Regression," *Reference Manual on Scientific Evidence*, 3rd Edition, Federal Judicial Center, the National Academies Press, Washington, D.C., 2011, pp. 327.

[77] Angrist, Joshua D., and Alan B. Krueger, "Empirical Strategies in Labor Economics," Handbook of Labor Economics, 1999. Orley C. Ashenfelter and David Card (Eds.), p. 1347 ("Researchers have employed a variety of 'trimming' techniques to try to minimize the effects of observations that may have been misreported.").

[78] Angrist, Joshua D., and Alan B. Krueger,, "Empirical Strategies in Labor Economics," Orley C. Ashenfelter and David Card, (Eds.), *Handbook of Labor Economics*, 1999, pp. 1347–1349.

[79] For example, in a paper that analyzed the economics of health care privatization, the authors analyzed the effectiveness of Medicare Advantage relative to fee-for-service policies for patients who used hospitals in NY State. The data they analyzed could not account for the fact that some patients that lived in NY State might cross the border to use hospitals in other states. To test that their findings were not sensitive to this issue, they ran their model removing beneficiaries that lived near the state boundary. See Duggan, Mark, Jonathan Gruber, and Boris Vabson, "The Consequences of Health Care Privatization: Evidence from Medicare Advantage Exits," *American Economic Journal: Economic Policy*, 10(1), 2018, p. 169. ("A final concern is that our inpatient data is limited to New York State only, and fails to track visits to hospitals in surrounding states. This could result in biased estimates, in the event that MA enrollees in New York have

64. An even stronger way to test whether the existence of roadblocks on the boundary drives my findings is to assume that every roadblock on the boundary was assigned to the census tract that it borders that has the lowest share of Black residents. In other words, it is possible to see if the statistically significant relationship between roadblock frequency and the share of the population that is Black holds even if every roadblock on the boundary was in fact in a census tract with the highest white share. This directly tests the concerns of Dr. Steward and Mr. Funderburk that roadblocks that are in census tracts with a relatively high share of Black residents are being placed there in error.

65. To conduct these sensitivities, my team hand-coded every roadblock and DUI in the CAD data under my supervision. That is, using Google Maps, my team reviewed every individual address or intersection and identified to which census tract these incidents belong. I further identified cases where such incidents could ostensibly be on the border between multiple census tracts. These steps both allow for a direct test of whether any measurement error in my original analysis drove my results.

66. Exhibits 5 and 6 present results from these sensitivity analyses. A clear pattern emerges – my main findings hold in all analyses. The sensitivities are as follows:

- In Exhibit 5, I remove from my analysis the roadblocks that, based on the GIS coding in my original report, are within 20 meters of a census tract border. As is clear, the coefficient on share of population that is Black remains statistically significant. I also perform sensitivities to this model to show that Dr. Steward's other criticisms of my original model related to simultaneity bias, normalizing variables by population, and including allegedly irrelevant control variables do not affect my findings. In all cases, my results are unchanged.[80]

- In Exhibit 6, I keep all of the roadblocks that, by manual inspection, appear to be on the boundary between two census tracts, and assign

differential rates of out-of-state inpatient usage, relative to those in FFS. We perform two different robustness checks, which involve the exclusion of populations more likely to use out-of-state hospitals. In one test, we exclude beneficiaries who live in exit counties and simultaneously reside within ten miles of a state border. In another test, we take a more systematic approach to identifying potential out-of-state hospital users by leveraging hospital service area (HSA) definitions; we exclude those living in exit counties AND simultaneously living in a zip code that is in a non-NY HSA.")

[80] See workpaper.

> them to the census tract that they border **that has the lowest share of Black residents**. As is clear, even when I make this assumption, my results hold. I again perform sensitivities to show that Dr. Steward's other criticisms my original model related to simultaneity bias, normalizing variables by population, and including allegedly irrelevant control variables do not affect my findings. In all cases, my results are unchanged.[81]

67. The fact that my model finds statistically significant and positive coefficients on the share of residents who are Black ***across all sensitivities*** demonstrates that my findings are unaffected by any imprecisions in the data due to roadblocks being on the boundary. In other words, the higher frequency of roadblocks in census tracts with a higher share of Black residents exists regardless of how the boundary roadblocks are treated.

4. CONCLUSION

68. Dr. Steward identifies a variety of critiques of my statistical model in his report, but my methodology is widely used in academic papers and by the Courts in litigation. In fact, Dr. Steward has used the same broad methodology (for example, making comparisons across geographic regions) in his own work.

69. Further, using sensitivity analyses, I have shown that the various claims Dr. Steward makes about the control variables in my model and the data have no consequence on the findings of my model. Consistent with standard methodology, I have run a wide variety of sensitivity analyses and robustness checks to my model (I have run over 50 different specifications of my model), and *all* of them support the same conclusion. The fact Dr. Steward has levied numerous criticisms of my model without even testing whether they affect the main findings of my model is inconsistent with professional standards.

Bryan Ricchetti, Ph.D.

[81] See workpaper.

APPENDIX A

BRYAN RICCHETTI, Ph.D.
Vice President

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ACADEMIC BACKGROUND

9/02 – 7/07 **Cornell University** Ithaca, New York

Ph.D., Economics, Applied Econometrics, Labor Economics

9/95 – 5/99 **Hamilton College** Clinton, New York

B.A., Economics with Honors, Magna Cum Laude, Phi Beta Kappa

PROFESSIONAL EXPERIENCE

9/07 – Present **Cornerstone Research, Inc.** Chicago, Illinois

Vice President

- Manage and conduct economic analysis for complex business litigation and regulatory matters, with specialization in antitrust, labor, class action, market manipulation and product misrepresentation matters.
- Expertise applying a wide range of empirical and theoretical methods to complicated market settings, including the application of statistical methods to analysis of large, proprietary data sets.
- Industry focus includes: retail, food and agriculture, the economics of distribution, and sports economics.

Selected Consulting Experience

- *Wage Discrimination Matter* Analyzed claims of gender discrimination. Oversaw the statistical analysis of wage and promotion patterns in internal personnel records for one of the largest employers in the world.
- *Monopsony Wage Fixing Cartel in Sports Industry* Analyzed claims that wages were capped by a sports regulatory organization. Oversaw statistical analysis of key issues.
- *Monopsony Wage Fixing Cartel in Service Industry* Analyzed claims of monopsony wage suppression in service industry. Managed and implemented statistical analysis of complex payroll records. Conducted liability and damages analysis.

- *Wage Discrimination Consulting Matters* Analyzed wage and promotion patterns in internal personnel records for large private company. Implemented econometric tests.
- *Wrongful Termination Gender Discrimination Matter* Analyzed wage and job history data to assess damage claims for employees who were allegedly wrongfully terminated by employer.
- *Alleged Cartels in Dairy Industry* (*Alice H. Allen et al. v. Dairy Farmers of America, Inc., et al. and Sweetwater Valley Farm, Inc., et al., v. Dean Foods Company, et al.*) Analyzed liability, damages, and class certification issues in multiple cases alleging vertical and horizontal conspiracies, price-fixing and quantity restrictions in the dairy industry. Analyzed pricing data at all levels of the industry, including issues of pass-trhough. Oversaw implementation of econometric analysis.
- *Alleged Monopoly and Foreclosure in Home Recreation Industry* Assessed claims of attempted monopoly and foreclosure by large distributor of home recreation products. Developed statistical model of damages to measure alleged impact of challenged conduct.
- *Merger in Food and Agriculture Industry* Analyzed potential economic impacts of a proposed merger between two large distributors. Assessed industry structure, competitive landscape, and possible price effects.
- *Regulatory matters involving state-level alcohol laws* Analyzed the economic impact of changes to state-level laws related to the distribution of beer, wine, and liquor in one state, and retail sale of liquor in another state. Assessed the potential effect of law change on alcohol consumption, tax revenue, and relevant social and economic outcomes.
- *LIBOR Manipulation Matters* Conceptualized and managed econometric analysis to understand the effect of the alleged conduct on rate trends. Prepared findings for regulatory investigation.

9/03 – 9/07 **US Census Bureau, LEHD** Ithaca, New York

Labor Economist

- Conducted econometric analysis related to research program on data confidentiality. Performed complex statistical modeling of key labor market outcomes. Authored internal papers and presentations.

7/99 – 7/2002 **MDRC** New York, New York

Research Assistant

- Conducted economic and statistical analyses of the effect of welfare-to-work programs on labor market outcomes.

APPENDIX A

BRYAN RICCHETTI, Ph.D.
Vice President, Cornerstone Research

TESTIMONY

Wal-Mart Puerto Rico, Inc. v. Juan C. Zaragoza-Gomez U.S. District Court, District of Puerto Rico. Retained by counsel for Plaintiff. Analyzed statistics issue. Filed affidavit on 1/19/16, deposed, and testified at trial.

Dunmars v. Board of Trustees of Community College District No. 510 and Jorie Menclewicz U.S. District Court, Northern District of Illinois, Eastern Division. Retained by counsel for Plaintiff. Damages analysis in lost wages matter. Report filed on 3/18/16.

Scott Swanson v. Epic Systems Corporation U.S. District Court, Western District of Wisconsin. Retained by counsel for Defendant. Rebuttal of Plaintiff expert regression analysis in age discrimination matter. Report filed on 9/5/17.

Boston Chapter, NAACP, Inc., et al. v. Nancy B. Beecher et al., and *Pedro Castro er al., v. Nancy B. Beecher et al.*, U.S. District Court, District of Massachusetts. Retained jointly by Plaintiffs and Defendants. Analysis of qualified labor pool for entry-level police and firefighers. Report filed on 10/11/17.

Winn-Dixie Stores, Inc. and Bi-Lo Holdings, LLC v. Southeast Milk, Inc., et. Al, U.S. District Court, Middle District of Florida, Jacksonville Division. Retained by counsel for Defendants. Analyzed liability and damages in alleged horizontal quantity restriction conspiracy. Report filed on 2/20/18.

Data Breach matter. Retained as statistics expert to analyze patterns of alleged data breach. Case resolved before report or testimony.

Antitrust matter. Retained to analyze procompetitive aspects of allegedly anticompetitive horizontal agreement. Case resolved before report or testimony.

ARTICLES AND PRESENTATIONS

Moderator, "The Capper Volstead Act - Lessons from the Trenches," ABA Teleconference Panel, December 9, 2016.

Panelist, 43rd Annual Fordham Conference on Antitrust Law and Policy, Economic Workshop – "Preparing for Deposition and Dealing with *Daubert* Challenges"

Expert Witness, ABA Antitrust Spring Meetings Mock Trial, Spring 2015 (Case involved antitrust issues raised by a hypothetical college athletic association's restrictions on amateur player compensation)

Expert Witness, Antitrust Law & Economics Institute for Federal Judges Mock Trial, October 2015 (Case involved antitrust issues raised by a hypothetical college athletic association's restrictions on amateur player compensation)

Co-author, "Applying Econometrics to Assess Market Definition and Market Power," *Econometrics: Legal, Practical, and Technical Issues*, American Bar Association Section of Antitrust Law.

Co-author, "Antitrust Impact in Indirect Purchaser Class Actions: The Need for Rigorous Analysis of Pass-Through," in the forthcoming Spring 2015 ABA Antitrust Distribution and Franchising Committee Newsletter

"Interpreting Comcast: Judge Koh's Decision in Brazil v. Dole Foods," in the Winter 2015 ABA Agriculture and Food Committee Newsletter.

Contributor, "How Effective Are Different Welfare-to-Work Approaches? Five-Year Adult and Child Impacts for Eleven Programs." December 2001, New York: MDRC.

Co-Author, ABA Handbook, Chapter on Pricing Regulations in the Dairy Industry, *Forthcoming.*

"Testing Disclosure Risk in the proposed SIPP-IRS-SSA Public Use Files," *Cornell University Dissertation,* August 2007 (and submitted to U.S. Census Bureau Disclosure Review Board, November 2016).

"Turnover as a Gateway to Symmetric Information: Testing Patterns of Entry into Personnel Records," *Cornell University Dissertation,* August 2007.

"Piece-Rates, Salary, Performance and Job Level," *Cornell University Dissertation,* August 2007.

ACADEMIC HONORS AND AWARDS

Walter Galenson Fellowship in Labor Economics, Cornell University	Spring 2005
Scholarship Prize in Economics, Hamilton College	Spring 1998

APPENDIX B

Documents Considered by Bryan Ricchetti, Ph.D.

Legal Pleadings

Defendants' Answer and Affirmative Defenses to the Complaint.	June 29, 2017
Opinion and Order, *Floyd et al. v. the City of New York* .	May 16, 2012
Plaintiffs' Opposition to Defendants' Joint Motion to Exclude Dwight Steward, Ph.D., as an Expert Witness, *Kelly v. Paschall* .	February 24, 2005

Expert Report

Expert Report of Bryan Ricchetti, Ph.D. with associated exhibits, appendices, and production.	March 13, 2018
Expert Report of William R. Funderburk with associated exhibits, appendices, and production.	May 8, 2018
Rebuttal Expert Report of Dwight D. Steward, Ph.D. RE: Bryan Ricchetti, Ph.D. with associated exhibits, appendices, and production.	May 8, 2018
Rebuttal Expert Report of Justin McCrary, Ph.D. with associated exhibits, appendices, and production.	July 2, 2018
Rebuttal Expert Report of Patricia Frontiera, Ph.D. with associated exhibits, appendices, and production.	July 2, 2018

Depositions

Deposition of Dwight Steward, Ph.D.	June 22, 2018

Academic Literature

Altonji, Joseph G., and Rebecca M. Blank, "Race and Gender in the Labor Market," Orley C. Ashenfelter and David Card, (Eds.), *Handbook of Labor Economics* , pp. 3143–3259.	1999
Angrist, Joshua D., and Alan B. Krueger, "Empirical Strategies in Labor Economics," Orley C. Ashenfelter and David Card (Eds.), *Handbook of Labor Economics* , pp. 1340–1349.	1999
Blau, Francine D., and Lawrence M. Kahn, "Gender Differences in Pay," *Journal of Economic Perspectives* , 14(4), pp. 75–99.	2000
Card, David, and Jesse Rothstein, "Racial Segregation and the Black-White Test Score Gap," *Journal of Public Economics* , 91(11-12), pp. 2158–2184.	2007
Chalfin, Aaron, and Justin McCrary, "Criminal Deterrence: A Review of the Literature," *Journal of Economic Literature* , 55(1), pp. 5–48.	2017
Chetty, Raj, Nathaniel Hendren, and Lawrence F. Katz, "The Effects of Exposure to Better Neighborhoods on Children: New Evidence from the Moving to Opportunity Experiment," *American Economic Review* , 106(4), pp. 855–902.	2016
Cutler, David M., and Edward L. Glaeser, "Are Ghettos Good or Bad?" *Quarterly Journal of Economics* , 112(3), pp. 827–872.	1997
Duggan, Mark, Jonathan Gruber, and Boris Vabson, "The Consequences of Health Care Privatization: Evidence from Medicare Advantage Exits," *American Economic Journal: Economic Policy* , 10(1), p. 153–186.	2018
Fagan, Jeffrey A., et al., "Street Stops and Broken Windows Revisited: The Demography and Logic of Proactive Policing in a Safe and Changing City," Stephen K. Rice and Michael D. White (Eds.), *Race, Ethnicity, and Policing: New and Essential Readings* , New York University Press, New York and London, pp. 309–348.	2009
Fridell, Lorie, "By The Numbers: A Guide for Analyzing Race Data from Vehicle Stops," *Police Executive Research Forum* .	2004
Gelman, Andrew, Jeffrey Fagan, and Alex Kiss, "An Analysis of the New York City Police Department's 'Stop-and-Frisk' Policy in the Context of Claims of Racial Bias," *Journal of American Statistical Association* , 109(479), pp. 813–823.	2007
Greene, William H., *Econometric Analysis* , 6th Edition, Pearson Prentice Hall.	2008

APPENDIX B

Documents Considered by Bryan Ricchetti, Ph.D.

Kennedy, Peter, *A Guide to Econometrics* , 6th Edition, Wiley-Blackwell, Malden, Massachusetts.	2008
Moore, D., and McCabe, G., *Introduction to the Practice of Statistics* , 5th Edition, W.H. Freeman and Company, New York.	2004
Oster, Emily, "Unobservable Selection and Coefficient Stability: Theory and Evidence," NBER Working Paper, pp. 1–47.	2016
Rougeau, Vincent D., and Keith N. Hylton, "Lending Discrimination: Economic Theory, Econometric Evidence, and the Community Reinvestment Act," *The Georgetown Law Journal* , 85(237), pp. 237–294.	1996
Rubinfeld, Daniel L., "Reference Guide on Multiple Regression," *Reference Manual on Scientific Evidence* , 3rd Edition, Federal Judicial Center, the National Academies Press, Washington, D.C.	2011
Wooldridge, Jeffery M., *Introductory Econometrics: A Modern Approach* , 5th Edition, South-Western Cengage Learning, Mason, Ohio.	2012

Data

American Community Survey Five Year Estimates for All Census Tracts in Madison County, Mississippi, Age and Sex	2012–2016
American Community Survey Five Year Estimates for All Census Tracts in Madison County, Mississippi, Employment Status	2012–2016
American Community Survey Five Year Estimates for All Census Tracts in Madison County, Mississippi, Housing Characteristics	2012–2016
American Community Survey Five Year Estimates for All Census Tracts in Madison County, Mississippi, Median Household Income	2012–2016
American Community Survey Five Year Estimates for All Census Tracts in Madison County, Mississippi, Race	2012–2016
American Community Survey Five Year Estimates for All Places in Madison County, Mississippi, Demographic and Housing Estimates	2016
American Community Survey Five Year Estimates for All Census Tracts in Madison County, Mississippi - Geodatabase Format, Shapefiles, available at *U.S. Census Bureau,* https://www.census.gov/geo/maps-data/data/tiger-data.html.	2015
Tiger/Line Shapefiles: Places - Mississippi, available at *U.S. Census Bureau* , https://www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2017&layergroup=Places.	2017
"Master CAD Report − To Be Produced.csv."	2012–2017
"2010 Census Tallies of Census Tracts, Block Groups & Blocks," available at *U.S. Census Bureau,* https://www.census.gov/geo/maps-data/data/tallies/tractblock.html.	2010
"2010 Census – Census Tract Reference Map: Madison County, MS," available at *U.S. Census Bureau,* https://www2.census.gov/geo/maps/dc10map/tract/st28_ms/c28089_madison/DC10CT_C28089_001.pdf	2010

APPENDIX C

APPENDIX C: SUPPLEMENTAL ANALYSIS

Exhibit 1

Model from first report[1]

Variable[2]	(1) With DUI Arrests[3]	(2) With Traffic Citations/Arrests[4]	(3) With Unemployment and Income[5]	(4) With Age and Vehicle Ownership[6]
Black Percentage of Population	0.02144	0.03193	0.06730	0.06218
standard error	0.00883	0.00921	0.01678	0.01721
p-value	0.01658	0.00073	0.00011	0.00044
Number of DUI Arrests Per 1,000 People	1.26540	1.48120	1.43700	1.38900
standard error	0.09188	0.11370	0.11650	0.12150
p-value	0.00000	0.00000	0.00000	0.00000
Number of Traffic Citations/Arrests Per 1,000 People		-0.11560	-0.08963	-0.10300
standard error		0.03797	0.03978	0.04075
p-value		0.00285	0.02606	0.01281
Median Household Income (in Thousands)			0.03174	0.02669
standard error			0.01528	0.01566
p-value			0.03994	0.09094
Unemployment Rate			-0.05076	-0.07771
standard error			0.07406	0.07727
p-value			0.49440	0.31660
Percentage of Households with At Least One Vehicle				-0.09574
standard error				0.07282
p-value				0.19120
Percentage of Population between Ages 15–24				-0.04544
standard error				0.04742
p-value				0.33980
Constant	-0.24690	-0.26490	-3.54750	7.05080
standard error	0.43940	0.42530	1.73230	7.83940
p-value	0.57520	0.53450	0.04275	0.37030
Observations	126	126	126	126
Adjusted R-Squared	0.625	0.649	0.661	0.662

Source: Master CAD Report – To Be Produced.csv; American Community Survey Five Year Estimates; US Census Bureau

Note:
[1] The dependent variable is the total number of CAD Roadblocks per 1,000 people per year by census tract.
[2] The Census Bureau has yet to release the 2013–2017 American Community Survey Five Year Estimates. Data from the 2012–2016 American Community Survey Five Year Estimates are used for observations in both 2016 and 2017.
[3] Specification (1) uses number of DUI arrests per 1,000 people per year by census tract as a control variable.
[4] Specification (2) uses number of traffic citations and arrests per 1,000 people per year by census tract as a control variable in addition to control variables used in specification (1).
[5] Specification (3) uses median household income and the unemployment rate by census tract as control variables in addition to control variables used in specification (2)
[6] Specification (4) uses the percentage of the population between 15–24 and vehicle ownership by census tract as control variables in addition to control variables used in specification (3).

APPENDIX C

Exhibit 2

Roadblock model using lagged DUIs and traffic citations[1]

Variable[2]	(1) With Lagged DUI Arrests[3]	(2) With Lagged Traffic Citations/ Arrests[4]	(3) With Unemployment and Income[5]	(4) With Age and Vehicle Ownership[6]
Black Percentage of Population	0.02868	0.03902	0.07293	0.06419
standard error	0.01103	0.01176	0.02122	0.02170
p-value	0.01067	0.00126	0.00086	0.00390
Number of DUI Arrests Per 1,000 People in the Previous Year	1.22160	1.41090	1.38420	1.31510
standard error	0.10950	0.13670	0.14200	0.14730
p-value	0.00000	0.00000	0.00000	0.00000
Number of Traffic Citations/Arrests Per 1,000 People in the Previous Year		-0.10240	-0.08153	-0.10660
standard error		0.04571	0.04812	0.05011
p-value		0.02734	0.09336	0.03588
Median Household Income (in Thousands)			0.03377	0.02684
standard error			0.01935	0.01986
p-value			0.08407	0.17980
Unemployment Rate			-0.02180	-0.07226
standard error			0.09820	0.10350
p-value			0.82480	0.48660
Percentage of Households with At Least One Vehicle				-0.15990
standard error				0.09510
p-value				0.09590
Percentage of Population between Ages 15–24				-0.04168
standard error				0.05878
p-value				0.48000
Constant	-0.24900	-0.26550	-3.83670	13.35700
standard error	0.55720	0.54660	2.21510	10.24500
p-value	0.65590	0.62820	0.08638	0.19540
Observations	105	105	105	105
Adjusted R-Squared	0.568	0.585	0.591	0.596

Source: Master CAD Report – To Be Produced.csv; American Community Survey Five Year Estimates; US Census Bureau

Note:
[1] The dependent variable is the total number of CAD Roadblocks per 1,000 people per year by census tract.
[2] The Census Bureau has yet to release the 2013–2017 American Community Survey Five Year Estimates. Data from the 2012–2016 American Community Survey Five Year Estimates are used for observations in both 2016 and 2017.
[3] Specification (1) uses number of DUI arrests per 1,000 people per year by census tract for the previous year as a control variable.
[4] Specification (2) uses number of traffic citations and arrests per 1,000 people per year by census tract for the previous year as a control variable in addition to control variables used in specification (1).
[5] Specification (3) uses median household income and the unemployment rate by census tract as control variables in addition to control variables used in specification (2)
[6] Specification (4) uses the percentage of the population between 15–24 and vehicle ownership by census tract as control variables in addition to control variables used in specification (3).

APPENDIX C

Exhibit 3

Roadblock model using non-normalized counts of roadblocks, DUIs and traffic citations[1]

Variable[2]	(1) With DUI Arrests and Log of Population[3]	(2) With Traffic Citations/Arrests[4]	(3) With Unemployment and Income[5]	(4) With Age and Vehicle Ownership[6]
Black Percentage of Population	0.12500	0.14130	0.23760	0.20860
standard error	0.03136	0.03031	0.05844	0.05903
p-value	0.00011	0.00001	0.00009	0.00059
Number of DUI Arrests	1.05360	1.45830	1.45080	1.35030
standard error	0.08596	0.14020	0.14290	0.14670
p-value	0.00000	0.00000	0.00000	0.00000
Number of Traffic Citations/Arrests		-0.10930	-0.10480	-0.10150
standard error		0.03069	0.03092	0.03044
p-value		0.00053	0.00095	0.00114
Median Household Income (in Thousands)			0.09240	0.06359
standard error			0.05289	0.05349
p-value			0.08322	0.23690
Unemployment Rate			-0.04921	-0.22140
standard error			0.25170	0.26070
p-value			0.84540	0.39750
Percentage of Households with At Least One Vehicle				-0.51320
standard error				0.23710
p-value				0.03250
Percentage of Population between Ages 15–24				-0.23700
standard error				0.16090
p-value				0.14340
Log of Total Population	1.84730	3.34150	2.77860	4.31560
standard error	1.53030	1.52100	1.54280	1.65470
p-value	0.22970	0.02993	0.07423	0.01029
Constant	-15.91100	-28.84600	-33.90100	10.15800
standard error	12.65800	12.62700	13.42000	23.54000
p-value	0.21120	0.02409	0.01284	0.66690
Observations	126	126	126	126
Adjusted R-Squared	0.669	0.698	0.702	0.712

Source: Master CAD Report – To Be Produced.csv; American Community Survey Five Year Estimates; US Census Bureau

Note:
[1] The dependent variable is the total number of CAD Roadblocks per year by census tract.
[2] The Census Bureau has yet to release the 2013–2017 American Community Survey Five Year Estimates. Data from the 2012–2016 American Community Survey FiveYear Estimates are used for observations in both 2016 and 2017.
[3] Specification (1) uses number of DUI arrests and log of total population per year by census tract as control variables.
[4] Specification (2) uses number of traffic citations and arrests per year by census tract as a control variable in addition to control variables used in specification (1).
[5] Specification (3) uses median household income and the unemployment rate by census tract as control variables in addition to control variables used in specification (2)
[6] Specification (4) uses the percentage of the population between 15–24 and vehicle ownership by census tract as control variables in addition to control variables used in specification (3).

APPENDIX C

Exhibit 4

Poisson roadblock model, using non-normalized counts of roadblocks, DUIs and traffic citations[1]

Variable[2]	(1) With DUI Arrests and Log of Population[3]	(2) With Traffic Citations/Arrests[4]	(3) With Unemployment and Income[5]	(4) With Age and Vehicle Ownership[6]
Black Percentage of Population	0.01272	0.01309	0.02010	0.01581
standard error	0.00274	0.00261	0.00561	0.00542
p-value	0.00000	0.00000	0.00034	0.00352
Number of DUI Arrests	0.05086	0.08273	0.08056	0.07171
standard error	0.00697	0.00973	0.01055	0.01005
p-value	0.00000	0.00000	0.00000	0.00000
Number of Traffic Citations/Arrests		-0.00817	-0.00771	-0.00722
standard error		0.00197	0.00209	0.00193
p-value		0.00003	0.00022	0.00018
Median Household Income (in Thousands)			0.00586	0.00268
standard error			0.00571	0.00541
p-value			0.30530	0.62020
Unemployment Rate			-0.01410	-0.04090
standard error			0.02725	0.02619
p-value			0.60490	0.11830
Percentage of Households with At Least One Vehicle				-0.06221
standard error				0.02127
p-value				0.00344
Percentage of Population between Ages 15–24				-0.03348
standard error				0.01708
p-value				0.05001
Log of Total Population	0.02614	0.30330	0.27440	0.44890
standard error	0.15750	0.15580	0.15360	0.14890
p-value	0.86820	0.05154	0.07407	0.00257
Constant	1.12380	-1.24750	-1.58360	3.90030
standard error	1.33680	1.34340	1.46870	2.37750
p-value	0.40050	0.35310	0.28090	0.10090
Observations	126	126	126	126

Source: Master CAD Report – To Be Produced.csv; American Community Survey Five Year Estimates; US Census Bureau

Note:
[1] The dependent variable is the total number of CAD Roadblocks per year by census tract. The above results are based on a Poisson regression.
[2] The Census Bureau has yet to release the 2013–2017 American Community Survey Five Year Estimates. Data from the 2012–2016 American Community Survey Five Year Estimates are used for observations in both 2016 and 2017.
[3] Specification (1) uses number of DUI arrests and log of total population per year by census tract as control variables.
[4] Specification (2) uses number of traffic citations and arrests per year by census tract as a control variable in addition to control variables used in specification (1).
[5] Specification (3) uses median household income and the unemployment rate by census tract as control variables in addition to control variables used in specification (2)
[6] Specification (4) uses the percentage of the population between 15–24 and vehicle ownership by census tract as control variables in addition to control variables used in specification (3).

APPENDIX C

Exhibit 5

Roadblock model excluding any roadblocks, DUIs, and traffic citations within 20 meters of a census tract border[1]

Variable[2]	(1) With DUI Arrests[3]	(2) With Traffic Citations/Arrests[4]	(3) With Unemployment and Income[5]	(4) With Age and Vehicle Ownership[6]
Black Percentage of Population	0.02946	0.03327	0.04749	0.05001
standard error	0.00713	0.00701	0.01270	0.01272
p-value	0.00007	0.00001	0.00028	0.00014
Number of DUI Arrests Per 1,000 People	1.04770	1.43590	1.34110	1.31990
standard error	0.13480	0.18210	0.19000	0.18910
p-value	0.00000	0.00000	0.00000	0.00000
Number of Traffic Citations/Arrests Per 1,000 People		-0.11380	-0.08541	-0.08288
standard error		0.03726	0.04075	0.04101
p-value		0.00276	0.03822	0.04552
Median Household Income (in Thousands)			0.00630	0.00330
standard error			0.01108	0.01112
p-value			0.57090	0.76730
Unemployment Rate			-0.07664	-0.06305
standard error			0.05551	0.05586
p-value			0.16990	0.26130
Percentage of Households with At Least One Vehicle				0.03786
standard error				0.04773
p-value				0.42920
Percentage of Population between Ages 15–24				-0.06793
standard error				0.03449
p-value				0.05123
Constant	-0.58100	-0.61020	-1.13470	-3.79440
standard error	0.30150	0.29190	1.24520	5.06250
p-value	0.05630	0.03868	0.36400	0.45500
Observations	126	126	126	126
Adjusted R-Squared	0.522	0.552	0.556	0.567

Source: Master CAD Report – To Be Produced.csv; American Community Survey Five Year Estimates; US Census Bureau

Note: [1] The dependent variable is the total number of CAD Roadblocks per 1,000 people per year by census tract, excluding any observations within 20 meters of a census boundary.
[2] The Census Bureau has yet to release the 2013–2017 American Community Survey Five Year Estimates. Data from the 2012–2016 American Community Survey Five Year Estimates are used for observations in both 2016 and 2017.
[3] Specification (1) uses number of DUI arrests per 1,000 people per year by census tract as a control variable, excluding any observations within 20 meters of a census boundary.
[4] Specification (2) uses number of traffic citations and arrests per 1,000 people per year by census tract as a control variable, excluding any observations within 20 meters of a census boundary, in addition to control variables used in specification (1).
[5] Specification (3) uses median household income and the unemployment rate by census tract as control variables in addition to control variables used in specification (2).
[6] Specification (4) uses the percentage of the population between 15–24 and vehicle ownership by census tract as control variables in addition to control variables used in specification (3).

APPENDIX C

Exhibit 6

Roadblock models with manual census tract assignment (assignment to least black census tracts) *[1]*

Variable[2]	(1) With DUI Arrests[3]	(2) With Traffic Citations/Arrests[4]	(3) With Unemployment and Income[5]	(4) With Age and Vehicle Ownership[6]
Black Percentage of Population	0.02232	0.03162	0.06865	0.06738
standard error	0.00945	0.01057	0.01859	0.01905
p-value	0.01974	0.00337	0.00034	0.00058
Number of DUI Arrests Per 1,000 People	1.42130	1.49630	1.46860	1.45470
standard error	0.09755	0.10440	0.10440	0.11350
p-value	0.00000	0.00000	0.00000	0.00000
Number of Traffic Citations/Arrests Per 1,000 People		-0.08350	-0.05404	-0.06575
standard error		0.04425	0.04631	0.04779
p-value		0.06151	0.24550	0.17150
Median Household Income (in Thousands)			0.03021	0.02622
standard error			0.01676	0.01712
p-value			0.07397	0.12830
Unemployment Rate			-0.08549	-0.08617
standard error			0.08205	0.08520
p-value			0.29960	0.31390
Percentage of Households with At Least One Vehicle				-0.02922
standard error				0.07918
p-value				0.71280
Percentage of Population between Ages 15–24				-0.06568
standard error				0.05274
p-value				0.21550
Constant	-0.61130	-0.73740	-3.74670	0.31330
standard error	0.48960	0.48920	1.90350	8.45160
p-value	0.21420	0.13430	0.05133	0.97050
Observations	126	126	126	126
Adjusted R-Squared	0.641	0.648	0.660	0.659

Source:
Master CAD Report - To Be Produced.csv; American Community Survey Five Year Estimates, U.S. Census Bureau; Hand Coded CAD Roadblocks and DUIs.xlsx; Duplicate Clean Address by Date.xlsx
Note:
[1] The dependent variable is the hand-coded total number of CAD Roadblocks per 1,000 people per year by census tract.
[2] The Census Bureau has yet to release the 2013–2017 American Community Survey Five Year Estimates. Data from the 2012–2016 American Community Survey Five Year Estimates are used for observations in both 2016 and 2017.
[3] Specification (1) uses the hand-coded number of DUI arrests per 1,000 people per year by census tract as a control variable.
[4] Specification (2) uses number of traffic citations and arrests per 1,000 people per year by census tract, excluding any arrests or citations within 20 meters of a census boundary, as a control variable in addition to control variables used in specification (1).
[5] Specification (3) uses median household income and the unemployment rate by census tract as control variables in addition to control variables used in specification (2)
[6] Specification (4) uses the percentage of the population between 15–24 and vehicle ownership by census tract as control variables in addition to control variables used in specification (3).

EXHIBIT 4

W. Funderburk

UNITED STATES DISTRICT COURT

FOR THE SOUTHERN DISTRICT OF MISSISSIPPI

NORTHERN DIVISION

LATOYA BROWN; LAWRENCE BLACKMON; HERBERT ANTHONY GREEN; KHADAFY MANNING; QUINNETTA MANNING; MARVIN McFIELD; NICHOLAS SINGLETON; STEVEN SMITH; BESSIE THOMAS; and BETTY JEAN WILLIAMS TUCKER, individually and on behalf of a class of all others similarly situated,

Plaintiffs,

vs. Civil Action No. 3:17-CV-00347-WHB-LRA

MADISON COUNTY, MISSISSIPPI; SHERIFF RANDALL S. TUCKER, in his official capacity; and MADISON COUNTY SHERIFF'S DEPUTIES JOHN DOES #1 THROUGH #6, in their individual capacities,

Defendants.

DEPOSITION OF WILLIAM FUNDERBURK

Gulfport, Mississippi

Wednesday, June 20, 2018

Reported by: DEBRA AMOS ISBELL, CCR,RDR,CRR

Job No: 143370

and they are key indicators of climate change. Their different habitats provide insight to allow us to project into the future what's going to happen along the coast.

Q. Have you ever worked as an expert witness before in any lawsuit?

A. No, sir.

Q. Have you ever worked as a consultant in a lawsuit before?

A. No, sir.

Q. Have you ever testified in court before?

A. No, sir.

Q. Have you ever testified in any sort of administrative proceeding?

A. Could you specify? What type of administrative proceeding?

Q. Like in front of a government agency.

A. No, sir.

Q. Do you have an understanding of what the lawsuit that this deposition is being taken in involves?

A. 30,000-foot-level understanding.

Q. And what is that understanding?

A. Basically Brown versus Madison County, I

in the Army?

A. Various side work. I went into the Army after I graduated high school. I did lawn stuff, manual labor-type stuff, as generally young men do.

Q. Right. And are you -- are you still in school? Are you pursuing a doctorate or other further degree?

A. Currently I elected to withdraw myself from the PhD program due to the extensive amount of family life I have. I have three children. So conducting a dissertation, research and attending classes is just a lot to do with three young children. So I had to prioritize. But currently I am finishing up a mathematics undergraduate. As an employee of the university, you have a benefit to take six hours of course work free of charge, so sort of continuing education. And be it that I have a minor in mathematics, it was sort of a no-brainer to try to just finish that up.

Q. So you mentioned that the research center does work with NOAA; right? Any other work with the federal government?

A. No, sir, not federal government.

Q. Any other work with state or local

governments?

A. I do oftentimes provide guidance and assistance to local municipalities in the development of their geographic information systems of their localities. I also am in charge of developing external relationships and seeking external funding for experiments to be performed such as remote sensing experiments, as listed in my CV.

Q. Have you ever worked with or worked for a law enforcement agency before this matter?

A. No, sir.

Q. You have military experience, but you don't have law enforcement experience; is that correct?

A. Correct.

Q. Do you have any expertise in statistics?

A. I would say yes.

Q. What is that?

A. I've used various statistics and statistical analyses in the scientific peer-review publications that I have put out as well as taken graduate-level statistics courses as well as undergraduate-level statistics courses.

Q. Are you familiar with the concept classical measurement error?

A. Not off the top of my head.

Q. Could you describe the work you did to prepare your report?

A. That's a pretty open-ended question. Can you be a little more specific, please?

Q. It looks like from your report that you spoke to at least one of the sheriff's deputies for Madison County named Rylon Thompson; is that correct?

A. That is correct; yes, sir.

Q. Did you speak to any other Madison County Sheriff's Department personnel?

A. No, I did not.

Q. Did you review any written materials prepared by Madison County Sheriff's Department personnel?

A. I did. I reviewed Mr. Sandridge's -- Mark Sandridge's -- I don't remember if he's a deputy or officer -- Mark Sandridge's report.

MR. NOBILE: Declaration for him.

Q. And other than -- I think it's Lieutenant Sandridge. Other than Lieutenant Sandridge's report -- sorry -- other than Lieutenant Sandridge's declaration, did you review any other written materials prepared by any other sheriff's department

software program.

Q. But that's not what you did in connection with this report; is that right? Like you didn't navigate to any of the points personally and then take any measurements; is that fair?

A. You're correct; yes, sir.

Q. So what sort of -- I guess what sort of ground truth validation did Deputy Thompson provide?

A. He provided the validation of where the actual roadblocks occurred, be it that we can't go back in time to when the roadblocks were occurring and go and take ground truth measurements or GPS point of that information. So you have to rely on someone who was there on the ground, boots on the ground, who can validate that that's the location they were at.

Q. Other than for this assignment, have you ever used a similar type of ground truth validation in your work?

A. Yes, sir, I have.

Q. Could you describe that?

A. Yeah. When we take remotely-sensed image data, classify it into habitat types, to perform a supervised classification you have to conduct a field survey or have ground truth information. So we do

this in just about every project that we do at the geospatial center. We navigate to a GPS point that we randomly assign in a software program or using ArcGIS, take a measurement with our high precision instrumentation and also take cardinal directional photographs, a certain radial distance away from a range pole that allows us to use photometric techniques to extrapolate habitat types beyond what's in a pixel. So, for example, if you had a pixel on the ground, you would be able to then estimate how far that habitat type goes out based on the photograph and the range pole measurements.

Q. The way you just described here, that wasn't what -- that wasn't the process that you ran with Deputy Thompson; right? Deputy Thompson didn't do any of these various technical steps that you outlined; is that correct?

A. He -- no, sir. You are correct. But the thing about ground truth information is -- so we document it for posterity and longevity. But if you have somebody who was on the ground conducting that -- in this case a roadblock -- in this case it is acceptable, it's an acceptable technique.

Q. Could you describe -- so the acceptable

Q. The two different methodologies.

A. Yes, yes, I believe it's a fair enough description, yes.

Q. And so we're talking about the methodology that was used with Deputy Thompson. Have you ever used that specific methodology other than in preparing this report?

A. Well, yes. But not as a scientist. I can give you an example from my service history, for example. If we were to get into a fire fight, when we would get back to Camp Diamondback, we'd have to fill out a serious incident report and describe a rough estimate, based on our recollection, of where we got into a fire fight at and that's acceptable to the higher chain of command. But that's about the closest example I could give you because I've been involved in scientific research for so long after that.

MR. NOBILE: Let me just make an objection here. I mean, it sounds like you're asking is it allowable to use firsthand -- or do you need to use firsthand versus secondhand or Officer Thompson's firsthand account of what happened. That's obviously allowed under the Federal Rules of Evidence. He's presented as an expert. You're fine to keep going

uses the methodology of relying on an interview subject's historical recollection?

A. I can't really recall every scientific paper I've ever reviewed or published or referenced. So there are repeat photography instances based upon memory. And I am not a rhetorician. So could you repeat the question one more time? I'm sorry.

Q. I said: Are you familiar with any scientific literature that uses the methodology of relying on an interviewed subject's historical recollection?

A. Yes.

Q. And what would that be?

MR. NOBILE: Objection.

Q. When he says objection, you can still answer unless he specifically tells you not to answer.

MR. NOBILE: Yeah. I'm making a foundation. This is for things for him and I to argue about later. I've just got to make a record so we can get to it later.

A. Sorry. What was the question again?

Q. So I asked: Are you familiar with any scientific literature that uses the methodology of relying on an interviewed subject's historical

recollection regarding the location of coordinates that you're trying to accurately plot?

A. Yes, I am.

Q. And then you said yes, and I asked you what is that literature.

A. I don't remember the title off the top of my head, but my wife is a rhetorician, and she deals with rhetorical landscapes all the time based off of memory and validates locations from historical interviews, documentation and memory. For example, she just recently came out with an article about Evelyn Gandy. I apologize, I don't remember the title off the top of my head.

Q. You said R-H-E-T-O-R-I-C-I-A-N?

A. I believe that's the correct spelling.

Q. That's a use of that term that I may not be familiar with. It seemed to me -- my understanding it's, you know, sort of the art of speaking well or something like that. You seem to be using it in a very different -- to have a very different meaning. Could you describe what that is?

A. I can't really describe exactly what rhetoricians do. I can just tell you what my wife does in sort of the loosely defined concept.

Q. You said that she deals with rhetorical landscapes. Can you describe what a rhetorical landscape is?

A. I cannot.

MR. NOBILE: Okay. Just to be clear, I mean, we're having a discussion about methodology by a different person's analysis in relying on witness information regarding the existence and occurrence of something. We're not having a deposition on whatever it is his wife does. So I just want to make sure, when you state his methodology --

MR. RETHY: I'm asking the question because this was his example where he's seen his methodology used.

MR. NOBILE: I object to that characterization. But you can go forward.

Q. So you said you've seen methodology of relying on an interviewed's subject's historical recollection used in your wife's field of expertise; is that fair?

A. Yes. I would also extend it to some of the more human side of geography, which is not what I deal with at all, where they deal with cultural analysis and that deals with many interviews, surveys,

research technique of relying on an interviewed subject's historical recollection used in your wife's discipline and in the field of human geography. Have you seen it used in any other fields?

MR. NOBILE: Objection, form.

A. I can't recall off the top of my head.

Q. Is that a research technique that you used in any paper that you've published?

A. Do you mean the technique of using firsthand memory?

Q. Correct.

A. To identify locations?

Q. Yes.

A. Not in anything that I have published, no, sir.

Q. Do you participate in peer review? Like are you on any committees that engage in peer review of other academic articles?

A. I have done peer reviews for the Journal of Coastal Research as well as the Journal of Geomorphology.

Q. Do you recall seeing this research technique we've been discussing used in any articles that you've reviewed as a peer reviewer?

A. No, sir. But I will just reiterate that this case is not a scientific investigation. So the datasets aren't necessarily comparable the way that you would treat them.

Q. When you interviewed Deputy Thompson, did he confirm to you that he had been present at each of the roadblocks that had been plotted in Dr. Ricchetti's report?

A. He was present at the roadblocks that are in my exhibits. I can't attest to if he was present at every roadblock in Dr. Ricchetti's report.

Q. Do you recall whether -- so you understand that a roadblock could occur at a particular location more than once; right?

A. Yes, sir.

Q. Did any of the roadblocks that you discussed with -- any of the roadblock locations that you discussed with Deputy Thompson, do you recall whether they were locations at which roadblocks had occurred more than once?

A. Could you restate the question one more time, please?

Q. So you discussed a subset of roadblock locations with Deputy Thompson; is that fair?

tract assignment errors that I have identified in my review and discussions. The exhibits referenced below are attached to my report."

So could you explain what you mean by an incomplete list?

A. So these were just a few examples. You know, I could have picked apart the entire dataset, but it would have taken me much longer. I could have gone through each point with Deputy Thompson. So this is essentially a subset.

Q. Did you select the subset?

A. I navigated -- I started in one corner of the Madison County map and just went to a couple of points and asked him about it. So I guess in terms of if I selected the subset, yeah.

MR. NOBILE: I'll just object. Objection to form.

Q. You say you went to a couple of points and asked Deputy Thompson about those points?

A. Yes.

Q. Did you ask Deputy Thompson about any points that didn't make it into this report?

A. Yeah, I did. You know, I could have had 80 pages of points here, you know. 80, I'm using 80 as

WAS MARKED FOR IDENTIFICATION.)

MR. RETHY: So we're going to mark this at the same time as Exhibit 3.

(EXHIBIT 3, DECLARATION OF RYLON THOMPSON, WAS MARKED FOR IDENTIFICATION.)

Q. So Exhibit 2 is the declaration of Mark Sandridge; is that correct?

A. Yes, sir.

Q. And Exhibit 3 is the declaration of Rylon Thompson; is that correct?

A. Yes, sir.

Q. Are you familiar with both of these documents?

A. No, sir, I have not reviewed the declaration of Rylon Thompson. I am familiar with the declaration of Lieutenant Sandridge.

Q. So let's turn back to your report, paragraph 48. So 48, subparagraph (a), states: "Exhibit 1 shows several roadblock locations near the reservoir."

What's your understanding of what the reservoir is?

A. The reservoir, my understanding of the reservoir is it is in the map of Exhibit 1, the body of water in the image.

Q. It says that this exhibit you're on, Exhibit 1, already shows several roadblock locations near the reservoir. Could you identify those locations on the exhibit?

MR. NOBILE: I'll just object. The exhibit speaks for itself. And to the extent that he can, given the degradation of the image in the printing.

A. So the image depicts point number 18 and point number 159 as well as point number 287, as listed in my report. It also depicts several other positions that are not listed in the paragraph. They are listed later on in the report.

Q. And there's -- there's an X marked on the page; is that right?

A. Yes, there is. That X depicts where the roadblock locations actually occurred versus the geocoded locations by Dr. Ricchetti that are incorrect.

Q. And who marked that X?

A. Deputy Thompson.

Q. And so the basis for your statement that that's where the roadblocks actually occurred, that's where Deputy Thompson identified them as having occurred?

A. Yes.

Q. You state then in 48, sub (a): "MCSD does not conduct roadblocks on Breakers Lane."

Do you see that?

A. I do.

Q. What's your basis for that statement?

A. Deputy Thompson, ground truth validation, which is completely reliable in this case.

Q. And what's your basis for saying that it's reliable?

A. He had boots on the ground. He was there. He helped set up these roadblocks. And my understanding is that these roadblocks occur in the same places every year or however frequent they set up.

Q. What's the basis for your understanding that they occur in the same places every year?

MR. NOBILE: Objection. Characterization.

A. Via Lieutenant Sandridge's report as well as the testimony of Deputy Thompson.

Q. So when you say "testimony," are you referring to interview?

A. Yeah. Sorry. I apologize for the misuse of terminology.

Q. And your basis for saying that Mr. Thompson our Deputy Thompson had boots on the ground, he was there, he helped set up these roadblocks, that's based on him telling you that that's the case; is that right?

A. Indeed, yes, sir.

Q. And did you do anything to verify that that was correct?

A. I don't necessarily need to verify that that was correct, you know. It's acceptable -- it's an acceptable technique to rely on somebody who was there and who did it.

Q. So you didn't do anything to verify that it was correct?

A. I can't go back in time and verify where the roadblocks actually occurred.

Q. But you didn't review any other documents or data or conduct any other interviews or anything, you know, not just going back in time?

MR. NOBILE: Objection, compound.

A. So I'm unclear on the question.

Q. I asked you: You didn't do anything to verify that what Mr. Deputy Thompson was saying was correct? I'm just basically asking for a yes or no.

MR. NOBILE: Yes. He talked to Officer Thompson, yeah.

MR. RETHY: And said he reviewed --

MR. NOBILE: In preparation of the deposition.

BY MR. RETHY:

Q. You testified earlier that you reviewed Lieutenant Sandridge's declaration, and that was something that you used to corroborate or verify information that you had received from Deputy Thompson. Is that right or is that wrong? He seems to be saying it's wrong.

A. I'll have to double check the transcripts to see exactly what I said. But I did review Lieutenant Sandridge's report.

Q. Solely in preparing for your deposition or in --

A. Yes.

Q. So you didn't review Lieutenant Sandridge's declaration in preparing your report?

A. In preparing my report?

Q. Correct.

A. No, no, sir.

MR. NOBILE: His report doesn't say that.

preparation for my report -- or the work I conducted for this report.

Q. And is Lieutenant Sandridge's declaration listed there?

A. I don't believe it is. No, it is not.

Q. So you did not review Lieutenant Sandridge's declaration in preparing your report?

A. That's correct. Yes. No, sir -- yes, that is correct. I did not review the declaration.

Q. And so any validation of the information in the report that you would have done using Lieutenant Sandridge's declaration would have occurred after you finalized and signed the report; is that correct?

A. Correct. Yes. But again, that doesn't change the fact that you can take Deputy Thompson's information as ground truth information. You can still use that.

Q. I was just trying to clear up that earlier testimony to understand when you've looked at Lieutenant Sandridge's declaration.

A. I understand.

Q. That's pretty much it for this line of questioning.

So let's go to your report, paragraph 48,

Q. So going to Exhibit 9, there's a blue X drawn on there; right?

A. Correct.

Q. And who drew that?

A. Deputy Thompson drew that blue X.

Q. Were you present when Deputy Thompson drew this blue X?

A. We printed out some images when we were doing the realtime investigation and interview where he drew these blue Xs.

Q. So you were present when he drew them?

A. Correct. You know, I go back to my example of the 30-meter pixel. So this is analogous to making up false information or creating false information from the resampling of coarse location information and creating fine geodetic coordinate information from it. Just like if you had a satellite image with 30-meter pixels and you attempted to reduce those pixels down to one meter, you would essentially be interpolating or making up information which would affect your subsequent analysis.

Q. Look at 49(k).

A. (a)?

Q. (k). Sorry. 48(k), the last subparagraph

of paragraph 48. And so 48(k) says: "Exhibit 11 shows point number 12. Per Dr. Ricchetti's geocoded coordinates, this roadblock is located in the middle of a local wildlife refuge on a dead-end road. It has been noted on Exhibit 11 where the roadblock actually would be on Highway 43."

So the notation refers to the blue X we see on Exhibit 11. Is that right?

A. Correct.

Q. And who drew that blue X?

A. Deputy Thompson.

Q. And is the basis for your assertion that this is where the road -- let me check the language -- that's where the roadblock would actually be at the blue X? The basis of your assertion is your interview with Deputy Thompson?

A. That is correct.

Q. And not any other information?

A. That is correct. He did mention -- I remember him mentioning during this exercise stating that point number 12, the geocoded location from Dr. Ricchetti, is on a dead-end road and how they would never conduct a roadblock on a dead-end road in the middle of a wildlife refuge area, which sort of,

analysis, yes.

Q. Earlier you mentioned the concept of classical measurement error. You said it wasn't a phrase you're familiar with; correct?

A. Not off the top of my head, no, sir.

Q. Do you have an understanding of how statistical analyses can address measurement errors in the datasets that are being analyzed?

A. Yeah.

Q. And what's your understanding of that?

MR. NOBILE: I want to make an objection because now you're asking for his statistical analysis or his interpretation of Dr. Ricchetti's statistical analysis. I don't want to say any more. I mean I just object to foundation, asking him to testify about something -- it sounds like you're approaching an area of inquiry that's beyond what he's been proffered for. But you can go ahead.

MR. RETHY: So look at page 17 of your report. The final words are Dr. Ricchetti's "statistical analysis is invalid as well." So I'm addressing that because that's something he's proffered for.

MR. NOBILE: If you've got something in his

geocoding process that Dr. Ricchetti performed split those roadblocks into two different areas. And now, they're not representative of one roadblock either. These are multiple roadblocks at this one location that have been split, it appears to be, across two different areas.

Let me look at point 18 real quick.

So in this case -- in this example point 18 falls out in census tract 301.07 as well as point 159. But that doesn't necessarily mean that that's going to be uniform across the entire dataset.

Q. Did you use a particular methodology in identifying this subset of geocoded data points that were going to be the subject of your analysis?

A. Pretty much randomly navigated to these points. You know, I hate to use the word "randomly chosen" because in science random is completely different than this exercise. So, again, these points were just randomly navigated to very quickly With Deputy Thompson.

Q. Right. But it wasn't random in like a statistical sense of choosing a random sample, like a statistically significant random sample dataset?

A. Correct. You're correct. Yes. This was

not a random subset of this data. However, you know, given that all this -- the geocoding process was done in a batch, as a batch process, there's no reason to think or believe that these are isolated incidents from the rest of the dataset.

Q. But to actually determine that would require additional analysis of additional data points?

MR. NOBILE: Objection, form.

A. To determine what?

Q. To determine whether there were additional -- to determine whether additional -- there were in fact additional errors, errors as defined by the process you used, you would have to analyze additional data points?

A. Not necessarily. I don't need to analyze additional data points, again, because these were all done in one batch process. And, now, the number of roadblocks that occur in these few exhibits is approximately 12 percent of the total roadblocks in a compiled unique roadblock dataset. So if we were to sample it statistically, 10 percent of the population data would be represented here. And by population, I don't mean people. In stats there's a sample population that you take to represent a target

"Given that the geographic analyses are the premise to the statistical argument, the statistical analyses is invalid as well."

When you are offering that opinion that the statistical analyses are invalid, are you offering that as an expert in statistical analysis?

A. No, sir, I'm not. I've had enough mathematics and taken mathematical logic courses. Given that the premise to any argument -- if the premise to the argument is invalid, thus the argument is invalid. That's classical logic as well as mathematical logic. And you take that when you take number theory course work.

Q. But you didn't do any statistical analysis that would confirm or refute Dr. Ricchetti's statistical analysis?

A. No, sir. I wasn't paid to do any statistical analysis here. Again, that's just classical mathematical logic.

MR. RETHY: That's all I've got.

EXAMINATION

BY MR. NOBILE:

Q. Okay. Just a few followup questions. Mr. Funderburk, can you go to Exhibit 12 of your

location information and assign fine, precise geodetic coordinates to it.

MR. NOBILE: No further questions.

MR. RETHY: All right. We're done.

(THE DEPOSITION OF WILLIAM FUNDERBURK WAS CONCLUDED AT 3:34 P.M.)

_____

WILLIAM FUNDERBURK

Subscribed and sworn to before me this _____ day of _____ 2018.

_____ _____

(Notary Public) My Commission Expires:

W. Funderburk

C E R T I F I C A T E

I do hereby certify that the foregoing proceedings were taken down by me and transcribed using computer-aided transcription and that the foregoing is a true and correct transcript of said proceedings.

I further certify that I am neither of counsel nor of kin to any of the parties, nor am I in anywise interested in the result of said cause.

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_____

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